SIEMENS

POWERMOBIL / ARCOSKOP

SP

Functional Description

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Diese Seite wurde bewußt leer gelassen.

Because the most electronical devices with Powermobil and Arcoskop are equal, this description of function can be used for both units. Differences are extra described.

The POWERMOBIL is a mobile X-ray unit with high output for the operating room.
The generator is equipped with a rotating anode tube and delivers a maximum output of 20 KW.

Modules and options in the monitor trolley

The following modules are located in the **monitor trolley** of the POWERMOBIL:

Power supply module

The power supply switch-on control and the power transformer of the POWERMOBIL are located here. The POWERMOBIL is also adapted to the relevant power voltage in this module.

Image memory

The image memory, MEMOSKOP-Fast, is available in two different versions (5000 or 10000 frames can be stored on hard disk).

Keyboard

A keyboard is required for data entry and for memory control corresponding to the installed image memory. The keyboard is available as Roman and universal keyboard. If a three-image memory is installed, no keyboard is necessary.

Monitors

The POWERMOBIL is equipped with two 100 Hz or 120 Hz monitors, respectively.
Additional devices can still be integrated in the monitor trolley optionally.

Multiformat camera

Two different multispot versions can be installed. An interface for controlling a laser camera is also available.

Video printer

If a video printer is installed, a special connection cable is required.

Video recorder

The different memory versions have a BAS output with 1 Vpp / 75 ohms with 50 Hz or 60 Hz respectively.

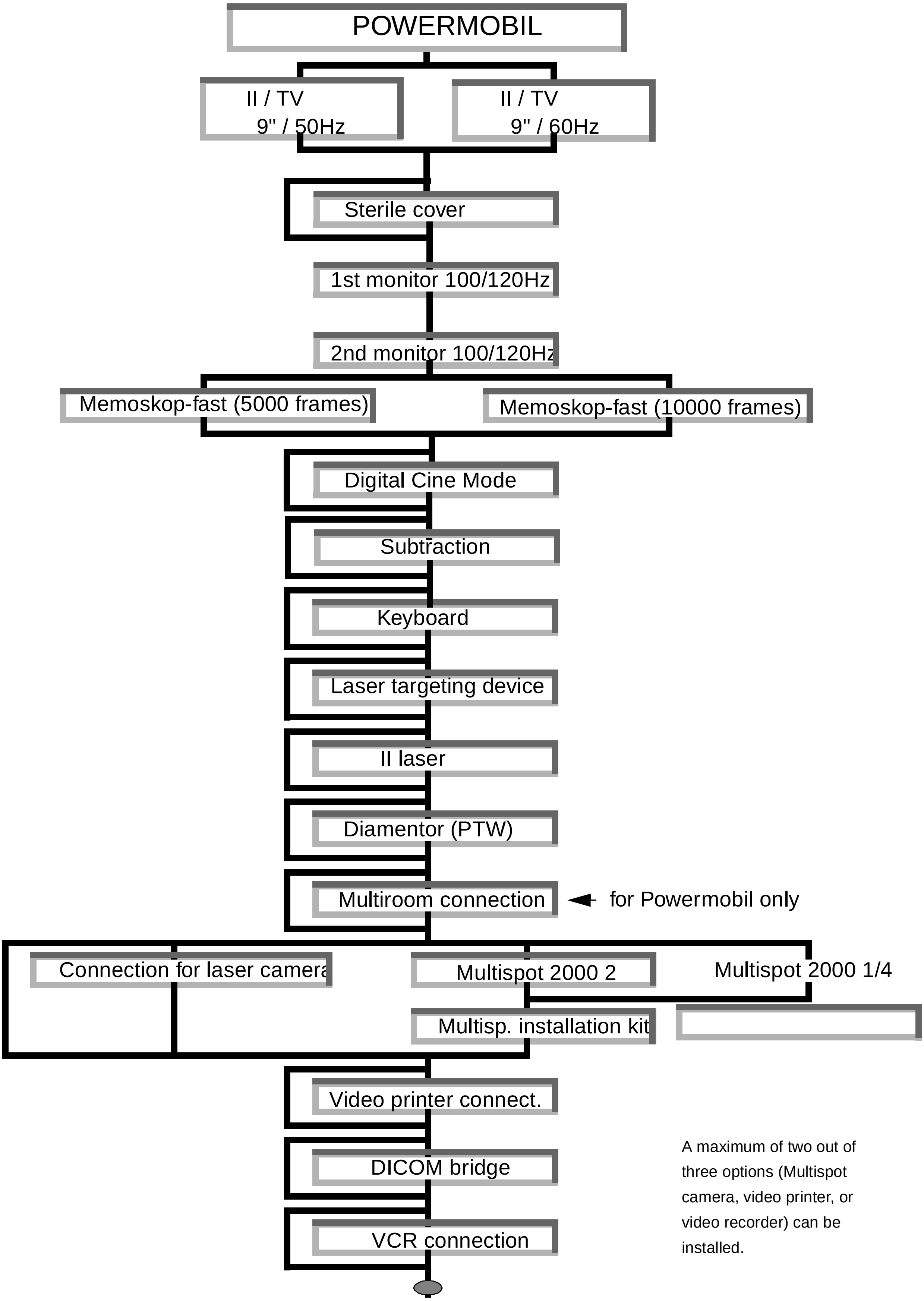
DICOM bridge

The images which are stored on the hard disk of the MEMOSKOP can be changed into the DICOM format by means of the DICOM bridge and then passed on to the hospital network.

Multiroom connection

A multiroom connection is available additionally in the POWERMOBIL as in the SIREMOBIL.

System overview



A maximum of two out of three options (Multispot camera, video printer, or video recorder) can be installed.

Components in the basic unit

Generator

Generator with high output for cardiological applications etc.

Image intensifier

A 23 cm (9") HDR metal-ceramic image intensifier is used in the POWERMOBIL.

TV system

VID-DC (as in SIREMOBIL ISO-C) with adaptation for DCM (Digital Cine Mode).

The following are optional:

Laser targeting device

For supporting special nailing techniques. The object can be positioned easily with this using the monitor image and the laser cross.

Image intensifier laser

For positioning the examination object.

PTW Diamentor

For determining the area dose product at the tube assembly output.

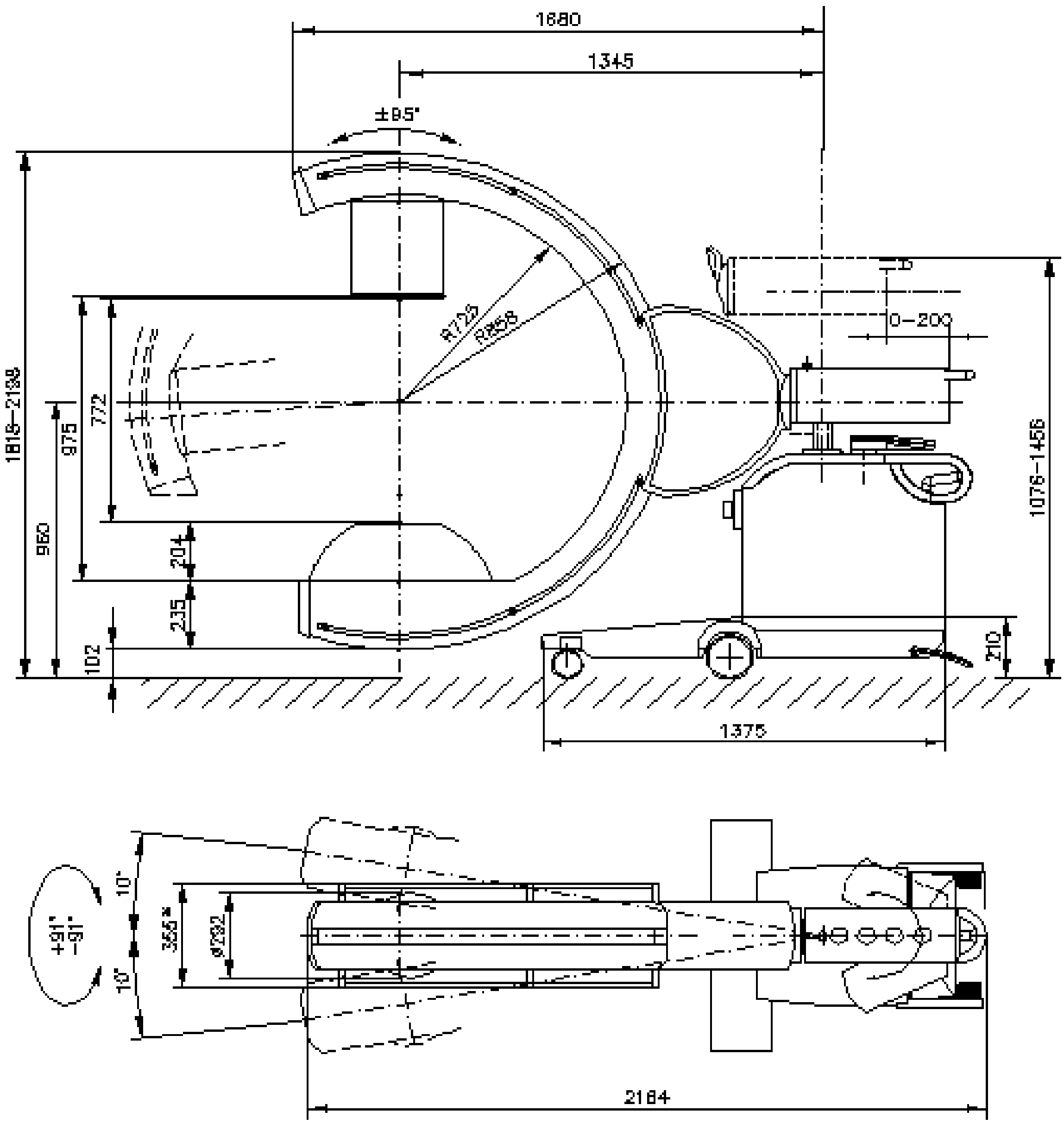
DCM

Digital Cine Mode

Subtraction

For digital subtraction angiography.

POWERMOBIL dimensions

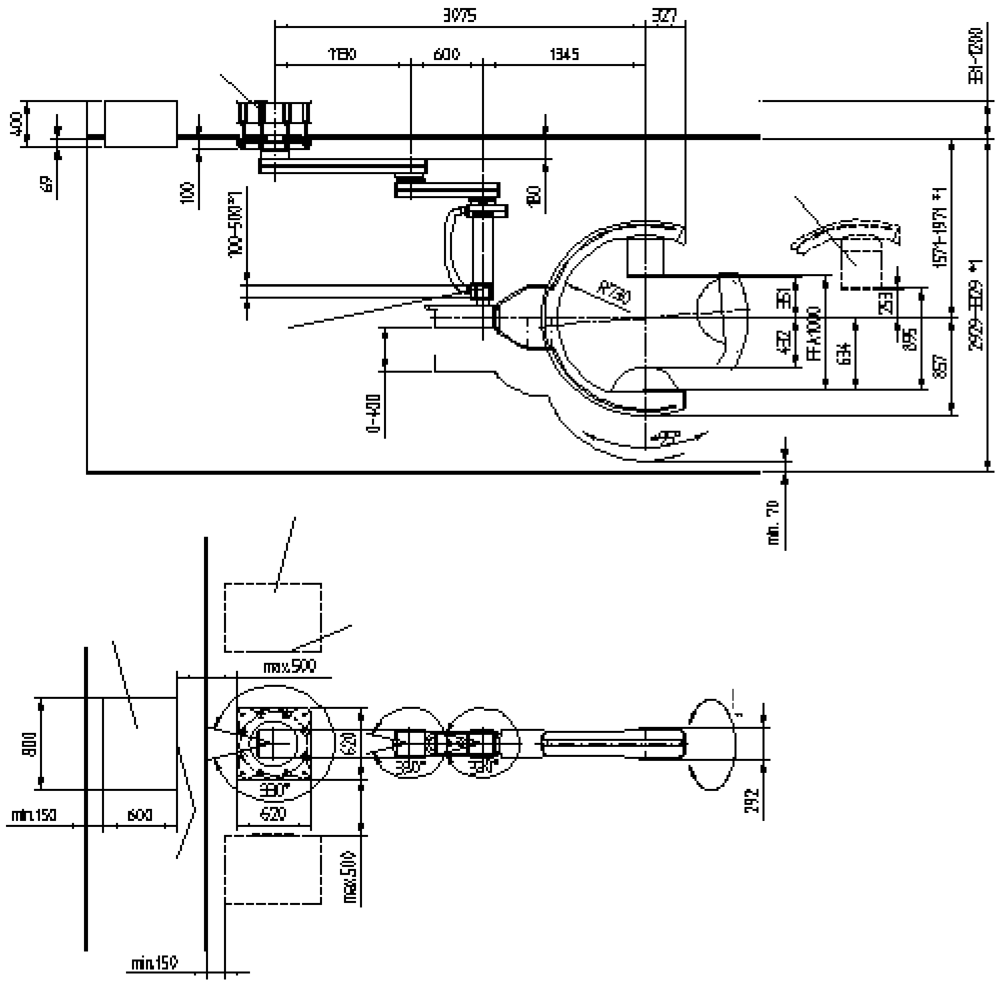


The C-arm of the POWERMOBIL is isocentric and can be rotated orbitally by 182°. The angulation is + 91°. The C-arm can also be swivelled + 10°.

Movements

orbital:	+ 91°
angulation	+ 91°
swivel	+ 10°
horizontal lift	200 mm
vertical lift	380 m

ARCOSKOP dimensions



Movements

orbital:	± 91°
angulation	± 91°
horizontal lift	400 mm

POWERMOBIL operating modes

The following operating modes can be selected with the POWERMOBIL:

FL	Fluoroscopy with LIH
PFC	Pulsed fluoroscopy / gap filling
DR	Digital radiography (single shot)
DCM	Digital Cine Mode

Optional operating modes are:

SUB	Digital subtraction
SUB-MAX	DSA total flow display
Roadmap	Catheter positioning aid

ARCOSKOP operating modes

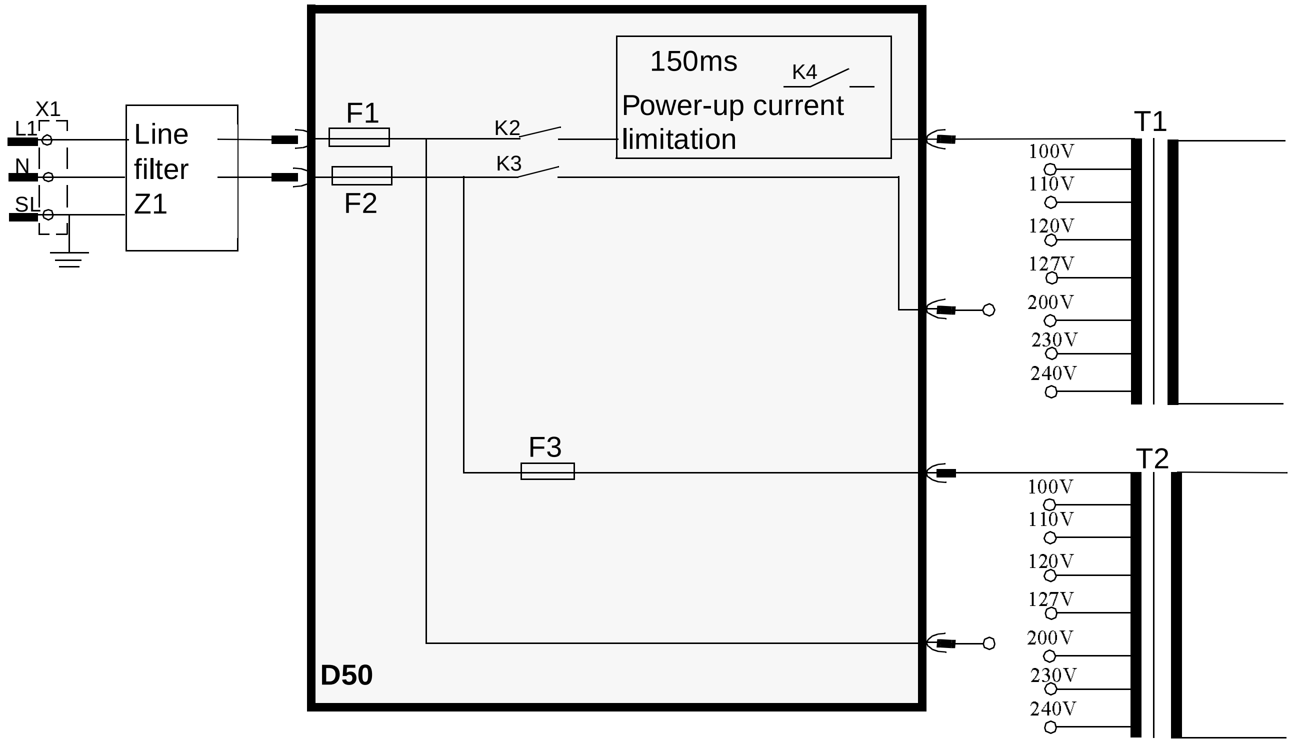
The following operating modes can be selected with the ARCOSKOP:

FL	Fluoroscopy with LIH
PFL	Pulsed fluoroscopy / gap filling
DR	Digital radiography (single shot)

Optional operating modes are:

DCM	Digital Cine Mode
SUB	Digital subtraction
SUB-MAX	DSA total flow display
Roadmap	Catheter positioning aid

Power input circuit



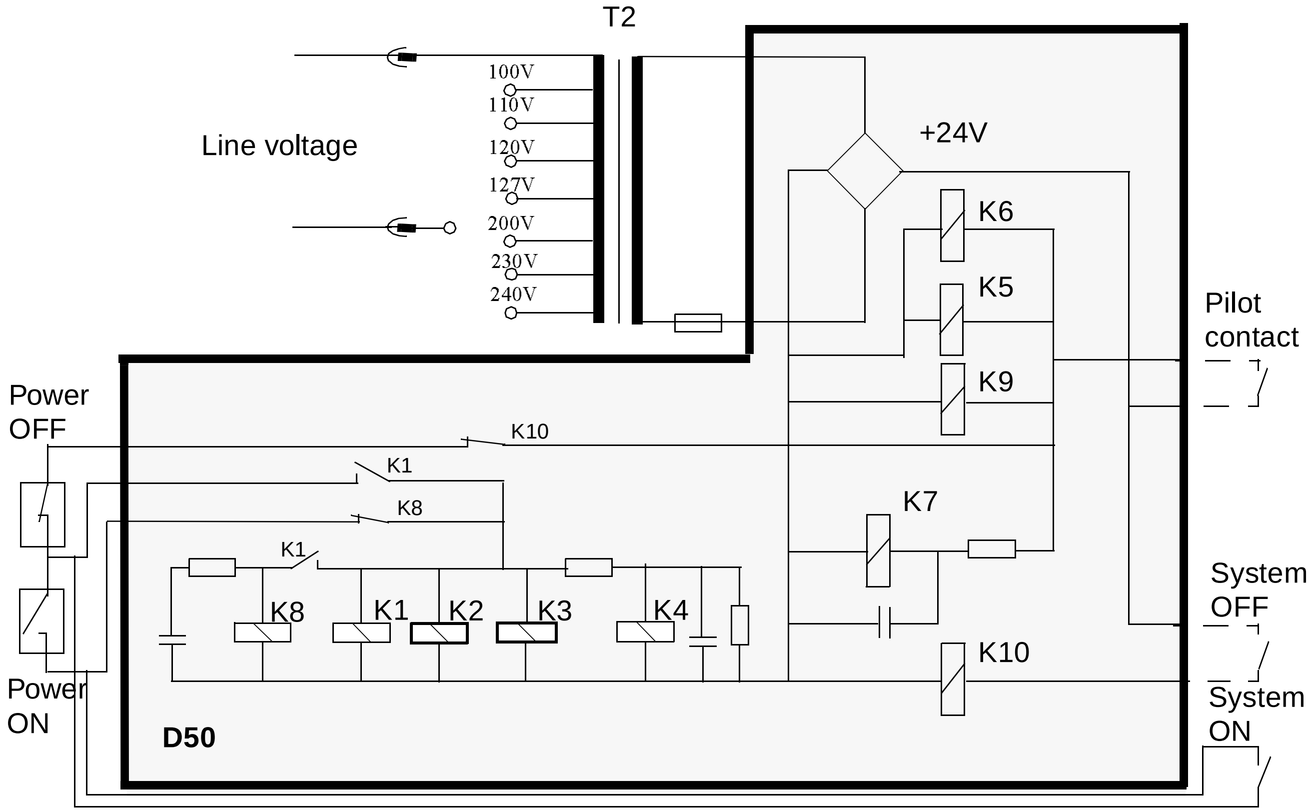
After the power plug is plugged in, the auxiliary transformer T2 is supplied immediately with voltage and delivers a voltage of 19 V~ for the power-up circuit.

The power transformer T1 is not connected to the power voltage until the POWERMOBIL is switched on and the relay contacts of the power-up relays K2 and K3 have switched on. The power-up current is limited directly after power ON for a time of 150 ms in order to avoid the power fuse tripping due to the power-up current peak.

Interference signals which come through the power supply or from the POWERMOBIL are suppressed by the mains filter Z1 in the input circuit.

The system line fuses are located after the line filter. Up to a line voltage of 127 V~ the Powermobil is protected with 20 A slow-blow fuses and as from 230 V~ with 15 A slow-blow fuses.

Power-up circuit



Relay function K1, K2, K3 / Power-up relays

In order to switch the unit on, the button for power ON in the monitor trolley or on the system control console must be activated. This switches the relays K1, K2 and K3 on immediately and the relay K4 with a time delay. The relay contact of relay K1 bridges over the power ON button, so that the unit remains switched on if the button is no longer pressed (self-hold). The relay contacts of K2 and K3 conduct the line voltage to the power transformer T1.

Relay function K4 / Power-up current limitation

The K4 relay switches with a time delay of 150 ms after power ON and then bridges over the NTC of the power-up current limitation circuit.

Relay function K8 / Power-up delay

If the power OFF button is pressed, the self-hold is interrupted and the relays K1, K2 and K3 are immediately de-energized. The K8 contact then remains open corresponding to the time constant of the parallel RC element, so that the unit can be switched back on only with a time delay (approx. 5 sec.)..

CAUTION	**After power OFF wait for approx. 30 seconds with the POWERMOBIL before switching back on, so that the hard disk in the MEMOSKOP-Fast is correctly initialized**

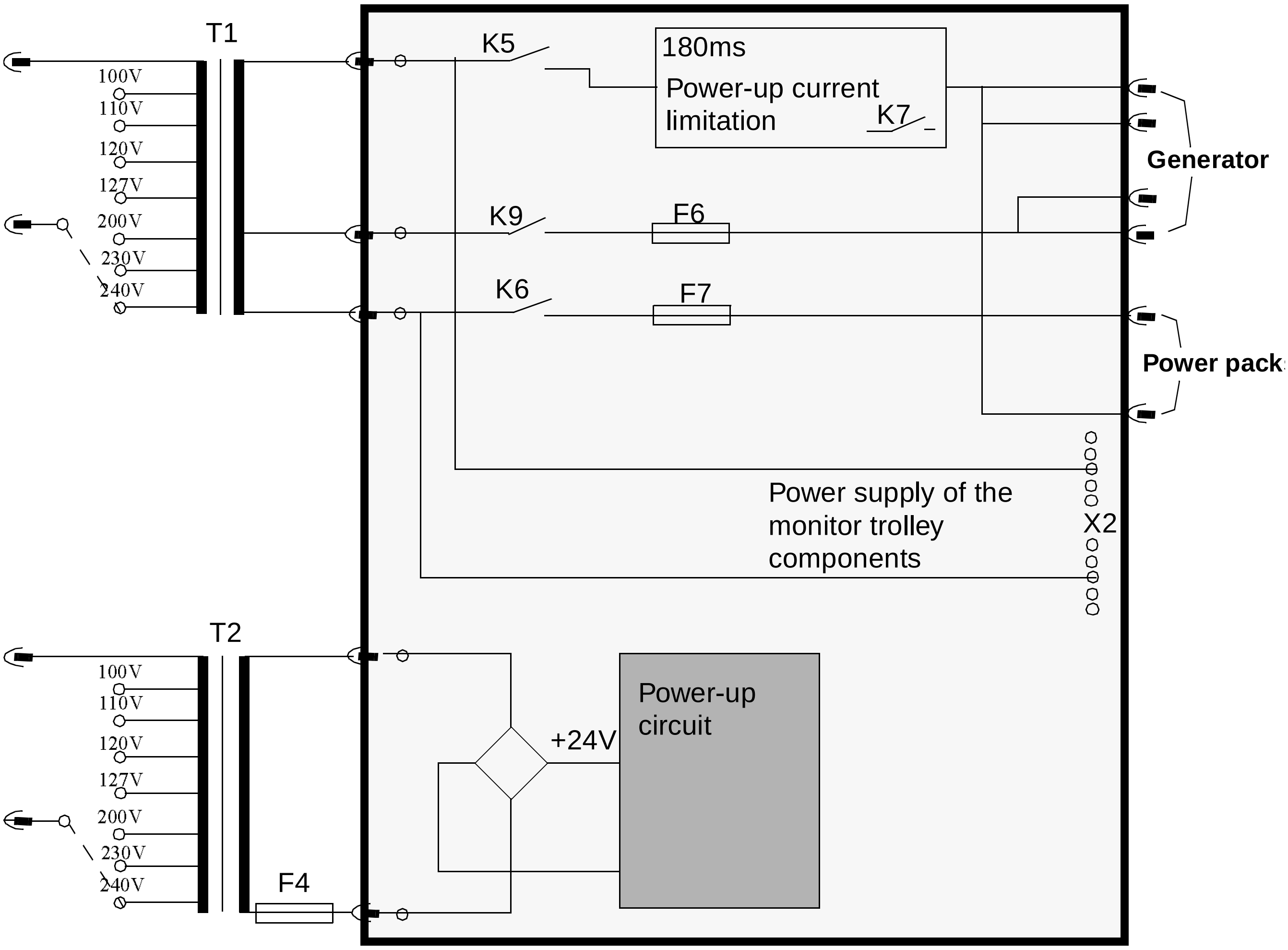
Relay function K10 / System OFF

If the button for switching off the system is operated on the POWERMOBIL console, the K10 contact opens and interrupts the power supply for the power-up relays K1, K2 and K3.

Relay function K5, K6, K7, K9 / Pilot

The relays K5, K6, K7 and K9 do not switch until the monitor cable is plugged into the POWERMOBIL basic unit.

Power supply components

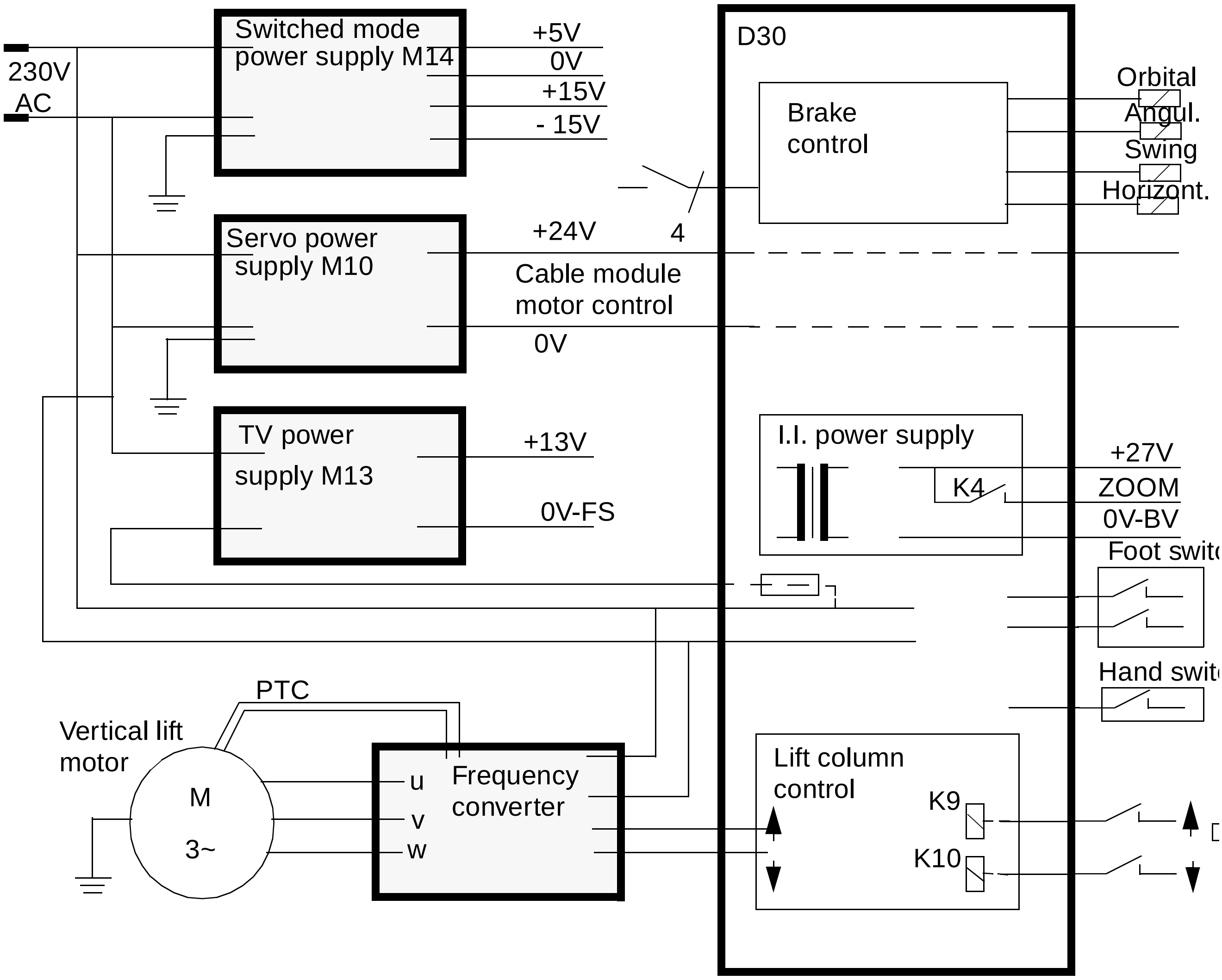


The contacts of the relays K5 and K9 pass the supply voltage of 190 V~ on to the generator provided the monitor cable is plugged in.

A further power-up current limitation circuit ensures that the current for the generator cannot become too high when plugging in the monitor cable. After 180 ms the K7 relay contact bridges over the NTC of the current limitation circuit.

The components in the monitor trolley, such as monitors, multiformat camera, video printer etc. are supplied through the connections X2.

Power supplies in the stand



The power supplies **M10, M13** and **M14** are located in the Powermobil basic unit.

The power supply **M14** delivers the unit voltages:

+5 V for: D1; D2; D30; control unit; camera rotation and laser aimer

+15 V

-15 V for: D1; D2; D30; iris collimator and filter diaphragm.

The power supply **M13** delivers a floating supply voltage for the television system of:

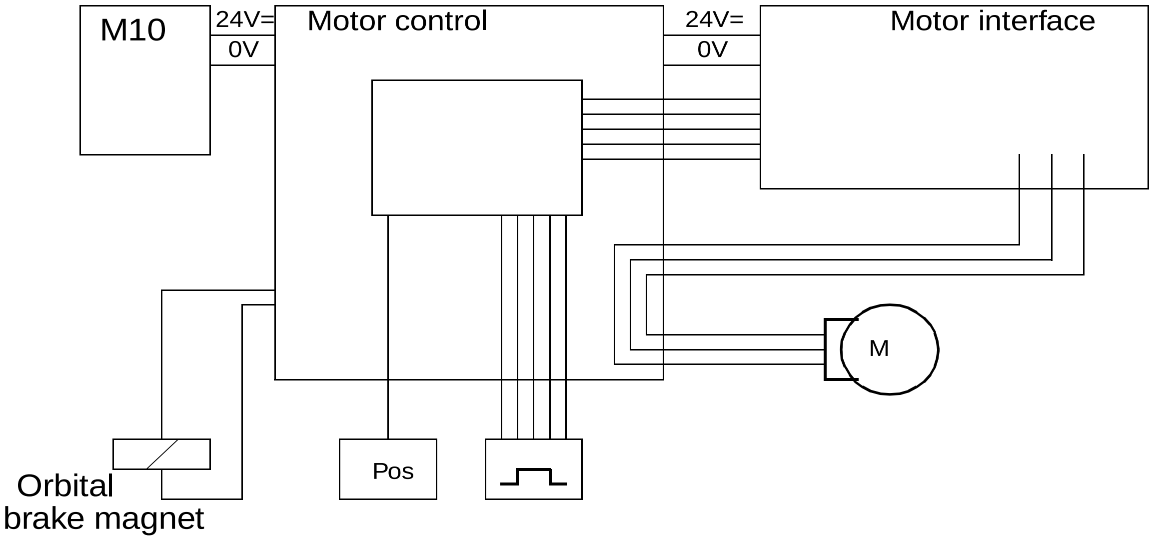
+13 V /1 A

M10 delivers a supply voltage for the electromagnetic brakes and for a motor for supporting the C-arm orbital movement.

A three-phase motor is used for raising or lowering the C-arm. A **frequency converter** supplies the operating voltage.

The **brake control circuit** on board D30 controls the individual brake magnets for the orbital movement, angulation, swivel movement, the horizontal lift and the vertical lift.

In the Powermobil the orbital rotation of the C-arm is supported by a motor. The motor is controlled through the **cable module motor control**.



ARCOSKOP rotary joint brakes

The rotary joint brakes in the ARCOSKOP are released with compressed air. For this purpose the solenoid valve db1/2 is controlled via the relay K1 on the board D30 for the rotary joint brake 1 and 2. The rotary joint brake db3 is released via the relay K4.

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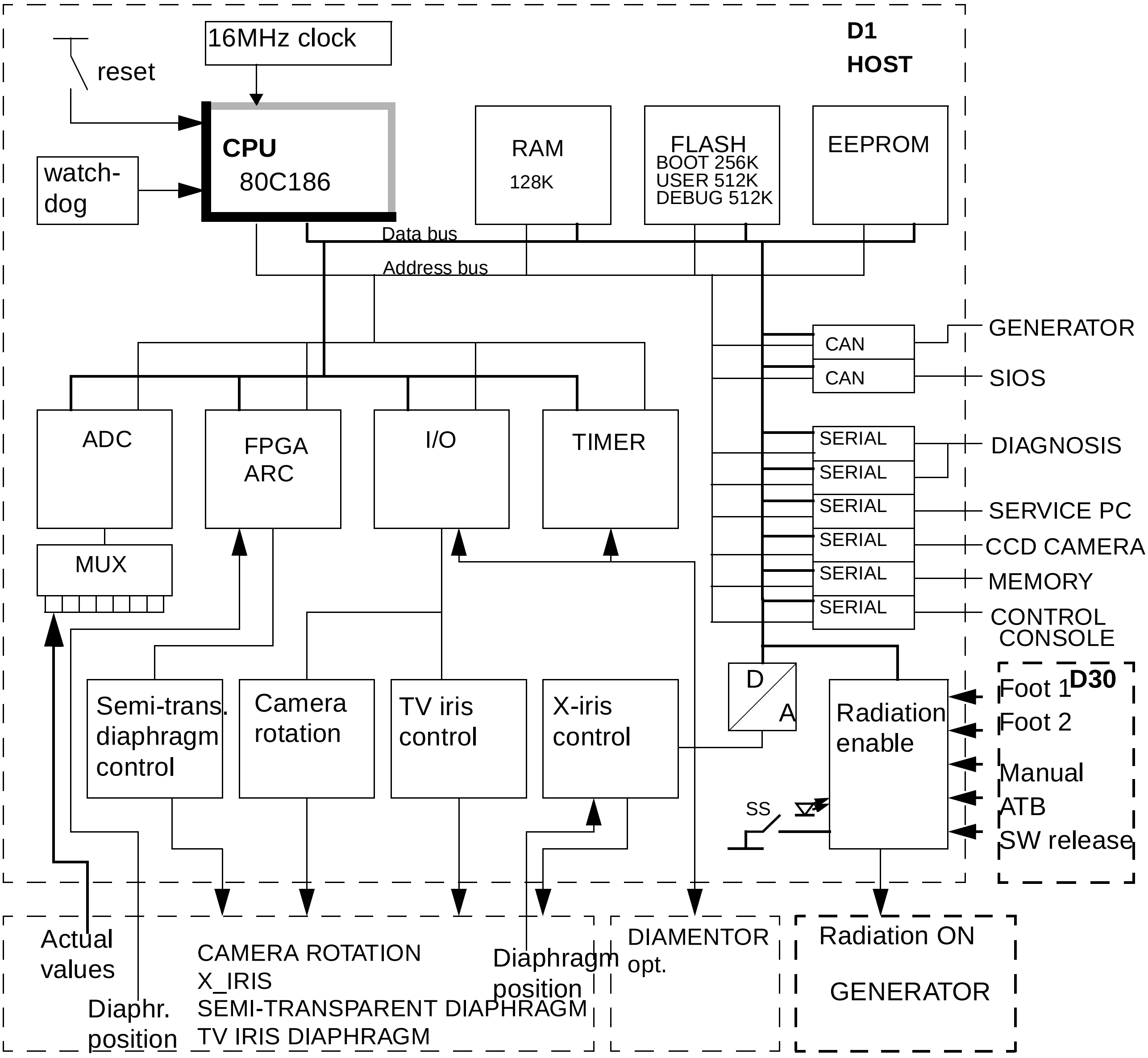
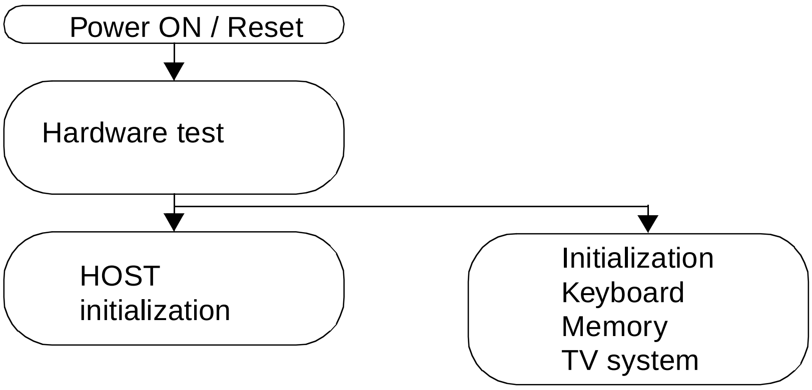
Host computer

The host computer and various control systems are located on the board D1.
The host is a computer system based on a 80C186 µC with a system clock of 16 MHz. The CPU memory area consists of the working memory (RAM), the memory for the system parameters (EEPROM) and the memory for the host software (FLASH). The internal communication is through I/O modules, the communication with peripheral system components and the service PC through six RS232 interfaces, which are partially designed as 20mA current loops. Analog actual values are selected by an 8:1 multiplexer and then converted into digital values with an A/D converter. The communication between host and generator is through a CAN interface. A second CAN interface is provided for the data exchange with the SIOS system.



Initialization



After the system is switched on and the supply voltages have built up, there is first a self-test of the processor system. If an error occurs in this, there is an error message on the 7-segment display on board D1. Once this self-test has been passed successfully, the system initialization is performed by the host computer. In this case, for example, standard values for KV and mA are calculated corresponding to the mean value of the selected characteristic, the displays stand in each case at 0 KV, 0 mA and 0 min. etc. The system initialization depends upon the memory-resident host download software. After there has been a self-test of board D1, the peripheral system components are initialized. The following processes are controlled depending upon the relevant events.

Service switches and displays on board D1

The service switches S2 and S3 and the reset button S1 are located on the board D1. S2 is a safety switch with which radiation release can be blocked. If S2 is in position 1, radiation release is enabled. The service switch S3 has four switching functions:

Serv_S0-Spare

Serv_S2-Download image memory (middle segment of V20 flashes)

Serv_S1-Download boot software (status display V20 runs vertically)

Serv_S3-Spare

Test results of the host system are displayed on the seven-segment status display. In this case fatal errors, non-fatal errors and ready display are output. If the segments of the status display rotate clockwise, the boot software is active and the system is ready. If a fatal error is detected, the error code is output permanently and a system standstill is forced. In the case of non-fatal errors, the corresponding error code is displayed for approx. 2 seconds. The system is not blocked in this case. In the system initialization the following test phases are displayed briefly.

0--Processor test   1--Checksum test   2--RAM test

3--Checksum-test application software

4--Watchdog test   L--FPGA is loaded (7 sec.)

A fatal error is determined with constant error display. In this case we have

o--Processor error 1--Checksum test not passed
2--RAM error detected 4--Watchdog does not function
E--CPU timer defective

In the case of fatal errors we have:

1--CAN0 controller defective 2--CAN1 controller defective
3--Serial interface SCCO defective
4--Serial interface SCC1 defective
6--ADC defective 7--RTC defective
8--IRQ controller defective 9--Silicon Identifier defective
F--FPGA not loaded
U--Unloaded (no executable user software loaded)

Display of a fatal error if S3.3 is switched on

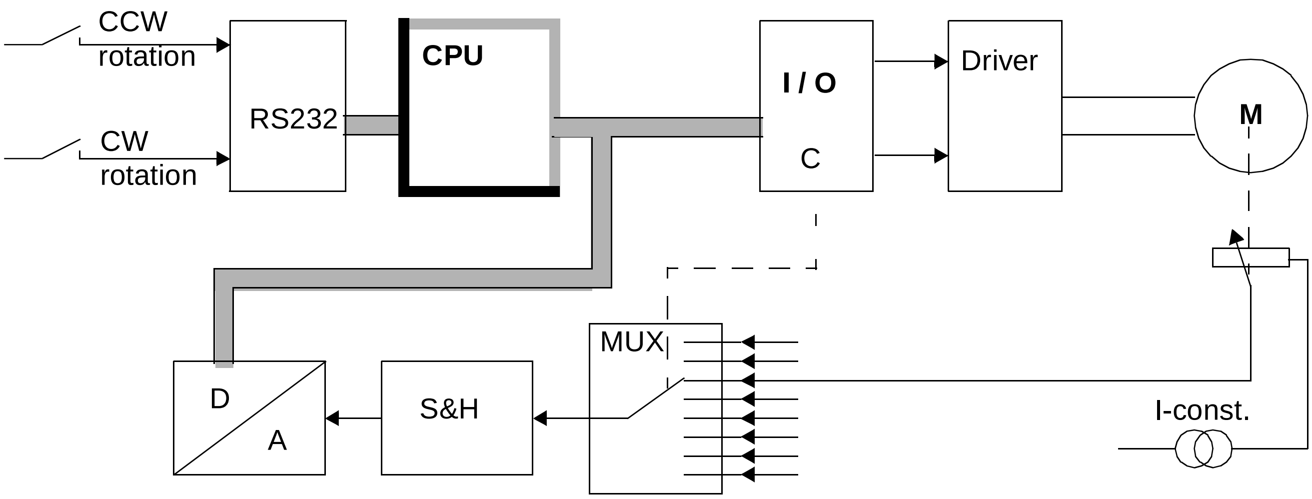
8--Telegram error NAK 9--Telegram error overrun
b--Message error Break error c--Checksum error
F--Framing error P--Parity error

In addition various LEDs for status or for error indication are located on the board D1.

V1	gn	+15 V
V2	gn	+5 V
V5	gn	Radiation ON
V10	gn	Radiation request
V13	gn	-15 V
V109	rd	Error $\pm$ 15 V
V121	Gn	SS ON
V162	rd	Watchdog timeout

Motor control systems

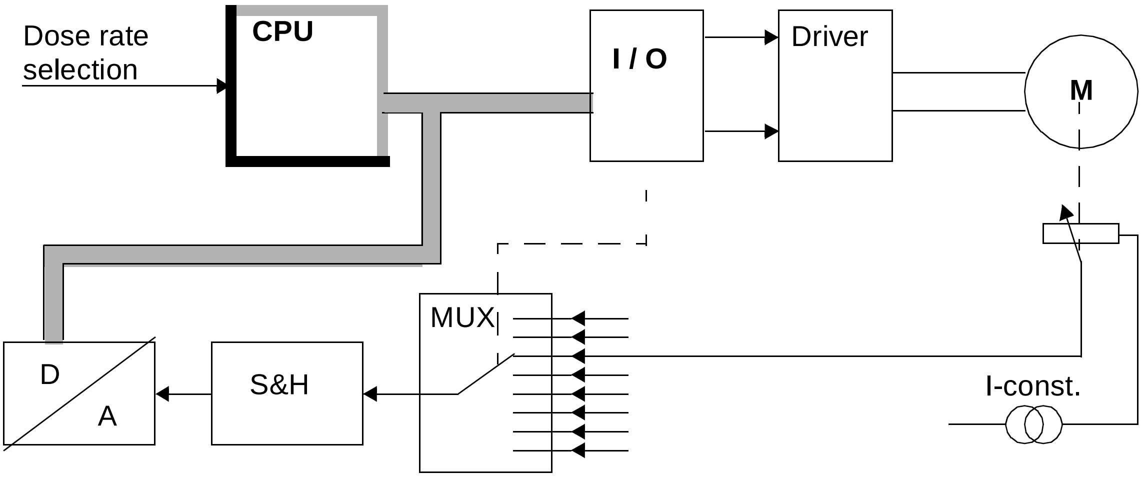
Camera rotation



The direction of rotation of the CCD camera is entered with the counterclockwise or clockwise buttons. The motor is driven through a driver and turns the CCD camera with the optical system. A mechanically coupled potentiometer delivers the actual value of the camera position. This actual value is forwarded to the CPU control through a multiplexer, temporarily stored in a S&H stage and then converted into a digital actual value. The CPU compares the actual value with the setpoint value which results by operating the direction of rotation buttons or by stored setpoint values, corresponding to the operating mode. The camera position display and a positioning mark, which is displayed with radiation ON in the monitor image, is also generated from the actual value signal.

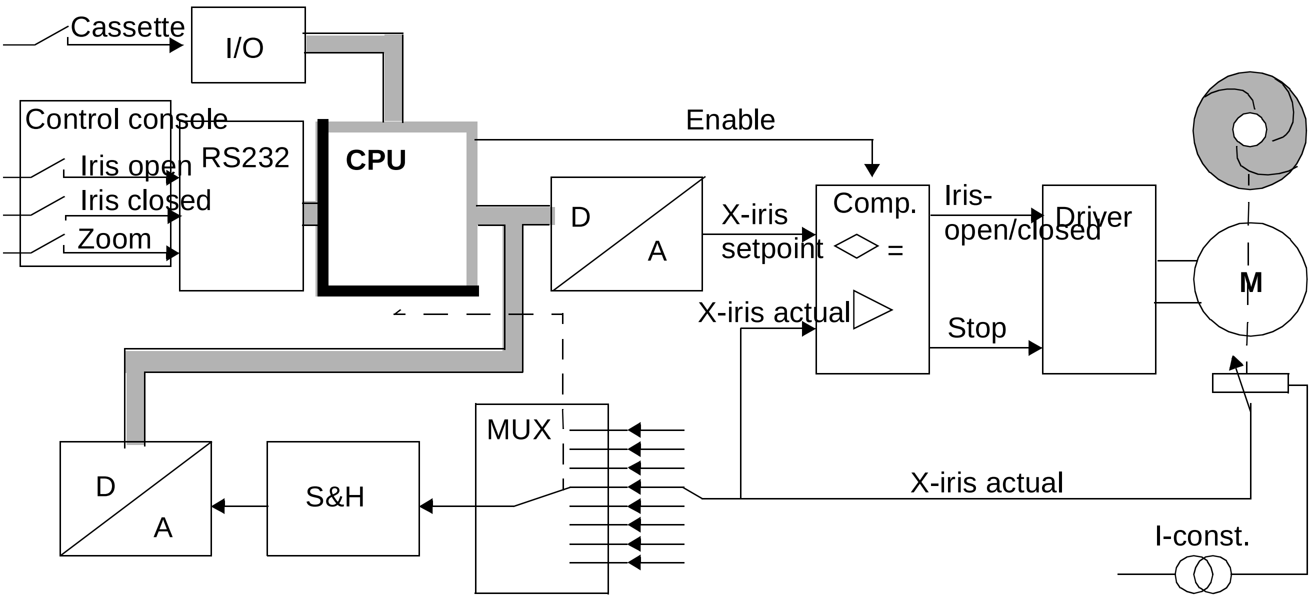
The CCD camera can be adjusted in a range from +220° to -220° ± 2°.

TV iris diaphragm control



Since the actual value for the dose rate control is derived in the POWERMOBIL from the image signal, the dose rate can be changed using the television iris diaphragm. To be able to select different dose rate values, a motor driven controllable TV iris diaphragm is installed. Three different dose rate values can be programmed via the organ programs. In this case different iris diaphragm openings are set, whereby the actual value becomes higher or lower. A different dose rate value results due to the comparison with the constant setpoint value.

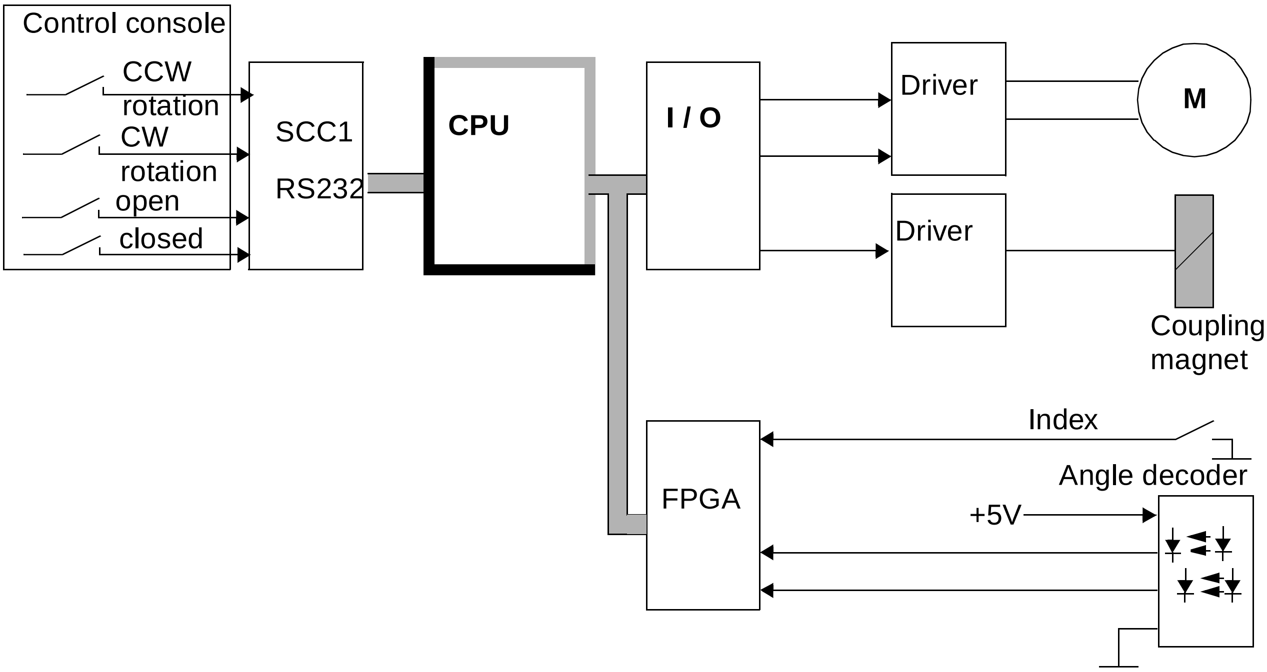
X-iris control



The X-iris is controlled by motor drive corresponding to the selection of the iris open / iris closed control buttons or depending upon the image intensifier format / cassette format. The drive motor is coupled mechanically with the iris diaphragm and an actual value potentiometer, so that the position of the iris diaphragm can be acquired. This actual value is fed to a comparator. In addition it is forwarded to the CPU through a multiplexer, temporarily stored in the S&H stage and converted with an A/D converter into a digital value. The CPU delivers a digital setpoint value, which is conducted D/A-converted to the comparator and compared there with the actual value. If the setpoint-actual difference exceeds a certain value, the diaphragm motor is driven. As long as setpoint=actual, the diaphragm motor remains in armature short circuit and thus is stationary. The enable signal from the CPU enables the control.

The X-iris can be opened in fluoroscopy or digital radiography maximally to the selected image intensifier format (full format or zoom). In radiography it is opened completely in the normal case. The X-iris diaphragm position for radiography is taken over only if in FL / DR mode both X-iris buttons (open/closed) are operated.
The LED in the iris diaphragm OPEN button lights up if the iris diaphragm is completely opened.

Semi-transparent diaphragm control



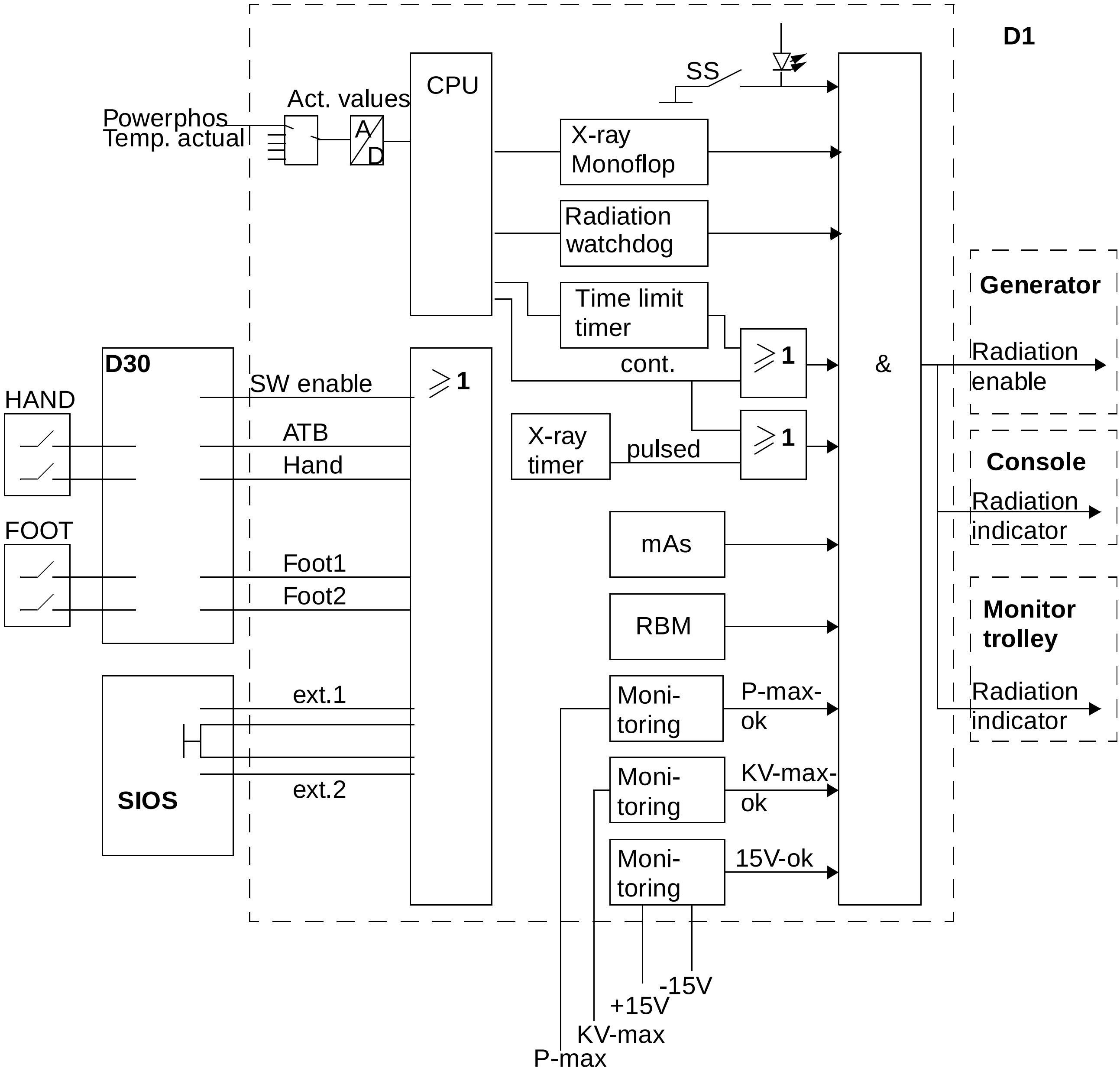
The filter diaphragm can be moved open and closed with the corresponding buttons. The diaphragm leaves can be shifted symmetrically to the center. In radiography the diaphragm leaves are moved into a park position outside the exposure format. The diaphragm leaves are moved open at power ON.

The motor and the coupling magnet are actuated simultaneously when opening and closing the diaphragm leaves. The coupling magnet switches the mechanism over, so that the filter diaphragm opens or closes.

To be able to adjust the filter diaphragm even without radiation, the momentary position is determined by means of an angle decoder. For this purpose an index position defined by a microswitch is moved to at power on and the programmed diaphragm setting is adjusted from here. Each time the index position is reached, the position value is set anew in order to achieve a higher control accuracy.

Radiation release

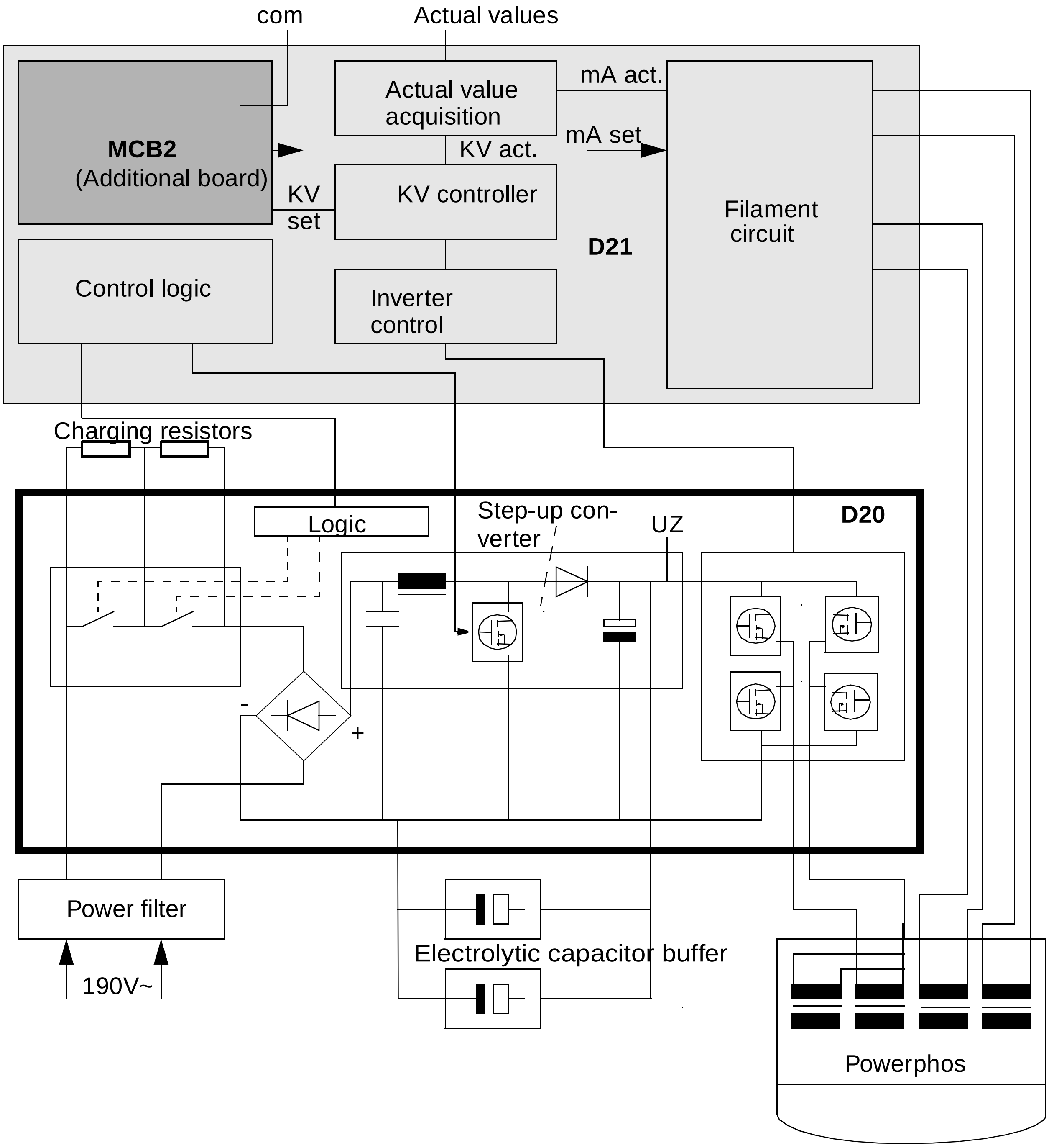
Block circuit diagram



Various conditions must be fulfilled so that the control signals for the inverter are enabled, or radiation is released. Signals such as KV-max, Sirephos gauge pressure, supply voltage, radiation watchdog and inverter short circuit blanking are interrogated. For demonstration or service purposes, the radiation release can be blocked via the K1 relay with the SS switch S2.

Generator overview

The generator consists of four modules: the generator control circuit D21, the power supply D20, the rotating anode starter D115 and the tube assembly (POWERPHOS).



The generator control is accommodated on the board D21. The generator processor is located on an additional board (MCB) which is plugged onto board D21.
This CPU card communicates with the host computer which among other things also provides the setpoint values for the KV and mA control. The KV control and the filament circuit are located on board D21. The control for the rotating anode starter D115 is also accommodated here. The DC bus circuit and the inverter for the high voltage generation are located on the power supply board D20.

Generator booting

After the line voltage has been switched on, the boot sequence in the generator is started and amongst other things a built-in self-test which checks the generator hardware is performed. If the hardware test has been completed successfully, the line voltage of 190 V~ is switched in with a power-up relay. To avoid an excessively high charging current for the DC bus circuit capacitors and electrolytic capacitor buffer, the charging current is limited by two charging resistors. The charging resistors are bridged over consecutively depending upon the charging current. The step-up converter which charges the DC bus circuit capacitors to a nominal voltage of approx. 400 V= is then enabled.
After the nominal voltage of the DC bus circuit is reached, the generator reports "Ready" to the host on board D1. The host computer then sends configuration data, setpoint values and the operating mode to the generator.

Operating modes

Continuous fluoroscopy FL:

The host board D1 sends the radiation request signal to the generator.
The rotating anode run-up is started and the rotating anode is accelerated until it reaches the nominal speed. The radiation is then released.

The monitors are active on radiation. The rotating anode is boosted cyclically.

FL data:

High voltage:	40 - 125 KV
Tube current:	0.2 - 8,9 mA
Focus:	small
Power max.:	550 W
Rotating anode drive frequency:	> 10 Hz

Pulsed fluoroscopy PFC (pulsefrequency $\leq$ 2pulses/sec.):

Pulsed fluoroscopy, with a pulsefrequency less or equal 2 pulses per second,is working with the same data as fluoroscopy. In this case, differently from continuous fluoroscopy, the radiation is switched on and off cyclically by the host.

Pulsed fluoroscopy PFC (pulsefrequency > 2 pulses/sec.):

PFC data:

High voltage:	40 - 125 KV
Tube current:	1 - 70mA
Focus:	small / large
Power (pulsed) max.:	4.4 KW / 8.8 KW
Rotating anode drive frequency:	40 - 50 Hz
Pulse frequency:	0.5 - 15 pulses/sec
Pulse width:	4 - 125 msec.

Digital Radiographie DR

DR data with a K-factor > 1:

High voltage:	40 - 125 KV
Tube current:	0.2 - 12 mA
Focus:	small
Rotating anode drive frequency:	> 10 Hz
Power max.:	1KW

DR with K-factor 1

Power max.:	20KW

Digital Cine Mode DCM:

DCM data:

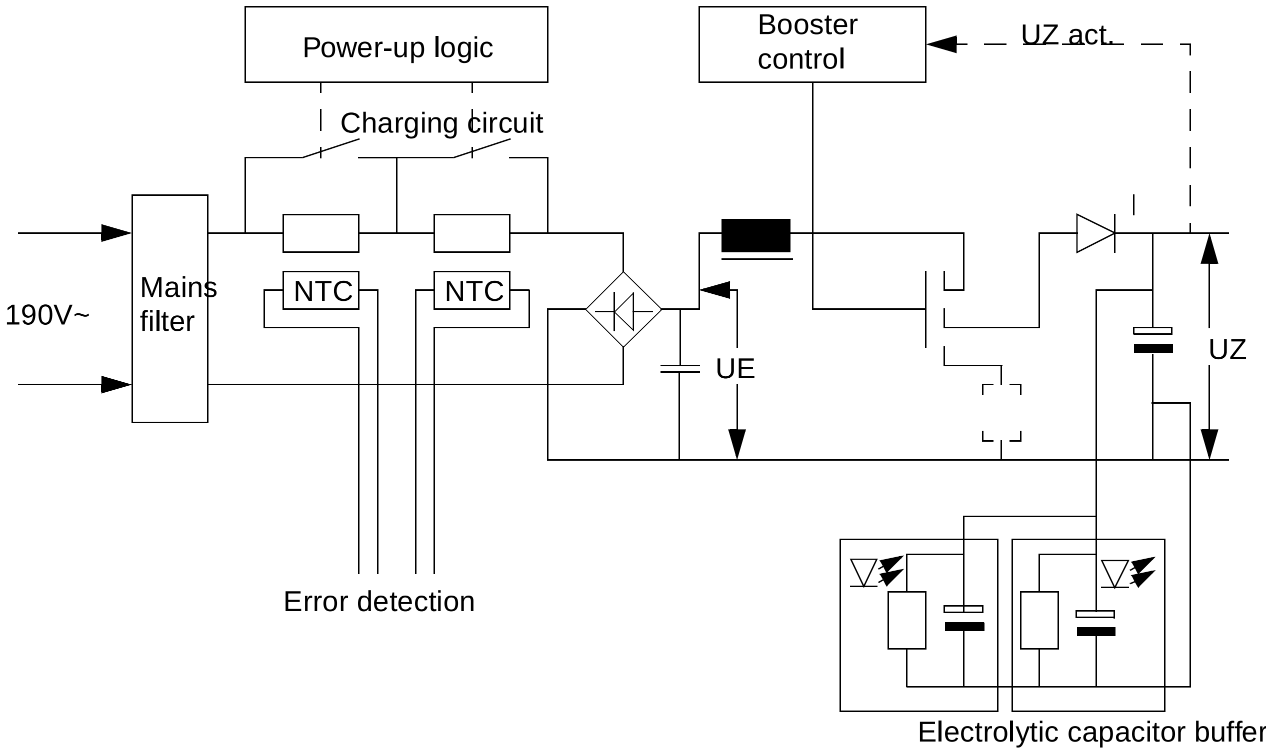
High voltage:	40 - 125 KV
Tube current:	10 - 250 mA
Focus:	small / large
Power max.	8.8 KW / 20 KW
Rotating anode drive frequency:	100 Hz
Pulse frequency:	0.5 - 15 pulses/sec

Emergency operation:

It is possible to release fluoroscopy at low power with the anode stationary.

DC bus circuit

A supply voltage of 190 V ~ is supplied by the unit power supply, which is located in the monitor trolley, to the generator through an external mains filter. A two-stage charging circuit limits the charging current for the DC bus circuit capacitors after switching on.
The charging resistors are bridged consecutively and thus an excessively high charging current is prevented. For error detection the temperature of the charging resistors is measured via two NTC resistors.

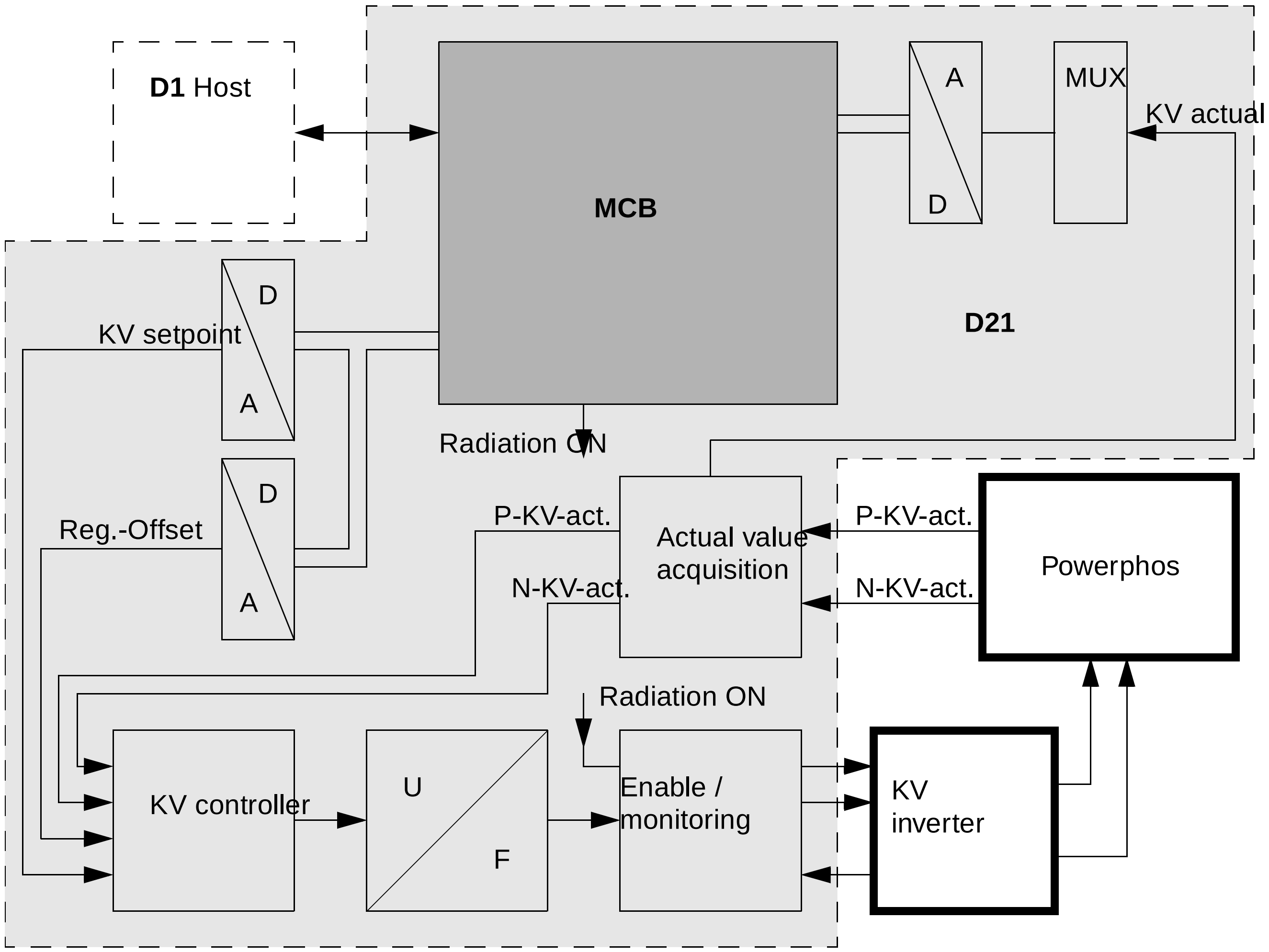


The supply voltage of 190 V~ is then rectified and converted with a secondary clocked voltage converter without potential separation to an output voltage UZ, which is higher than the input voltage UE. The DC bus circuit capacitors and the electrolytic capacitor buffers are thus charged to a nominal voltage of 400 V=. The charging condition of the capacitors is indicated with LEDs and monitored by the firmware. After the line voltage has been switched off, the capacitors are discharged. The discharging time is around 5 minutes. The capacitors can also be discharged via a service request.

NOTE	**The capacitors must be discharged in the service case !!! Danger to life!!!**

KV control

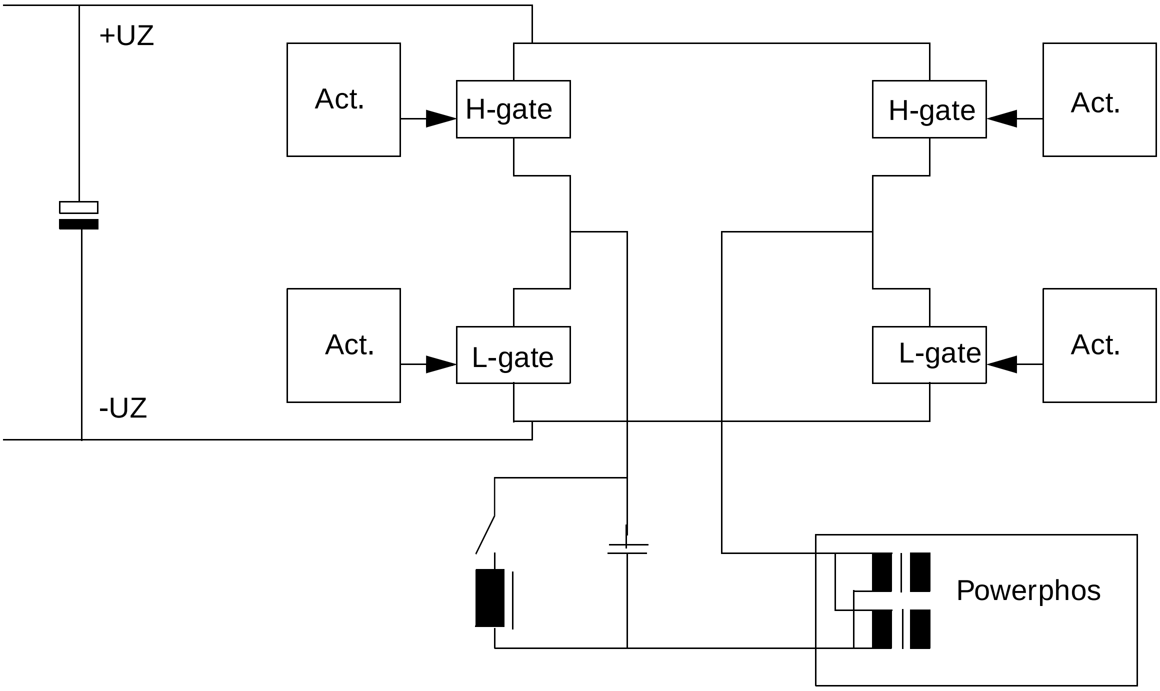
The control for the tube high voltage is located on board D21 in the generator.



The setpoint values for the KV control are transmitted digitally by the host board D1 through the generator processor board MCB to the KV control. The digital setpoint values are converted into analog values for the control and then fed to the controller.
The KV actual values P-KV-ACT and N-KV-ACT are delivered by the secondary high-voltage circuit and then combined to form the KV actual value. This KV actual value is forwarded for monitoring purposes to the generator processor and also to the KV controller.
The KV controller compares the KV actual value with the KV setpoint value. A control voltage for the following voltage frequency converter which generates the control signal for the inverter results from this comparison. The actuation for the inverter is in a frequency range of 20 to 35 KHz and thus determines the KV value. This control signal is fed to the inverter through an enable circuit. In the case of an error the control signals are blocked here, so that radiation can no longer be released.

Power circuit

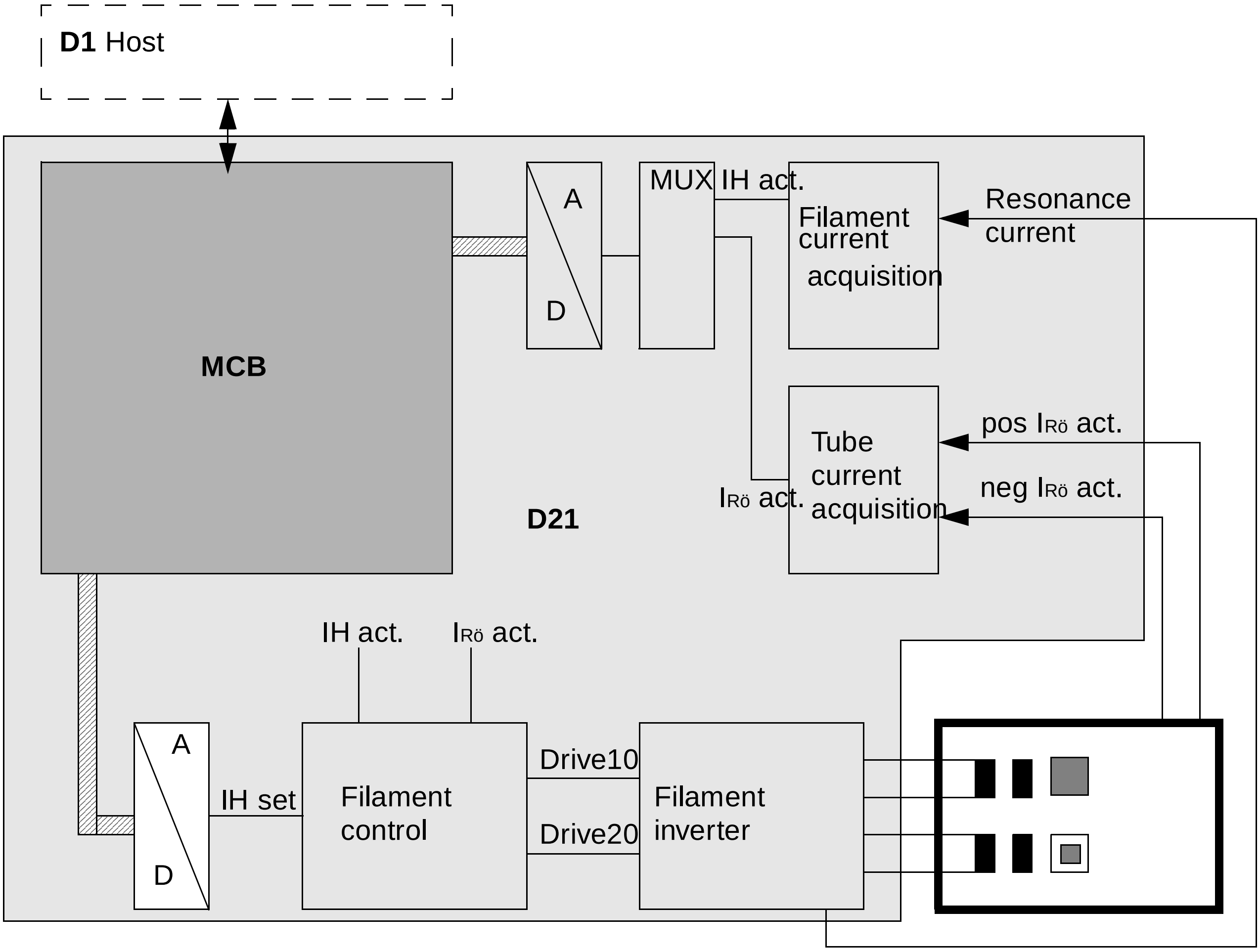
The inverter converts the DC bus circuit voltage into an alternating voltage which can be brought to anode voltage potential via the high-voltage transformer and a subsequent Villard circuit (voltage multiplication).
The actual power circuit consists of a bridge circuit, the power switching transistors of which are in an IGBT module.
The DC bus voltage is constantly changed in polarity using this bridge circuit in phase with the control signal which has been generated by the KV controller and is subsequently fed to an oscillating circuit which generates a sinusoidal voltage.



The oscillating circuit in the generator of the POWERMOBIL can be switched over. For small outputs, as for example in fluoroscopy, a combination of series and parallel oscillating circuit is used, whereas at high output a pure series oscillating circuit is used.

The collector emitter voltage of the power transistors is monitored for error detection. If an overcurrent is determined, there is an error message and the generator is blocked.

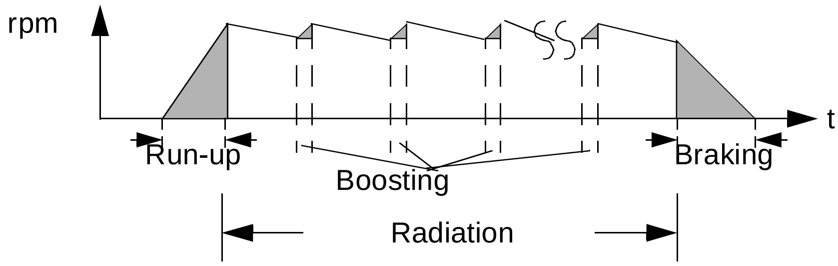
Filament circuit



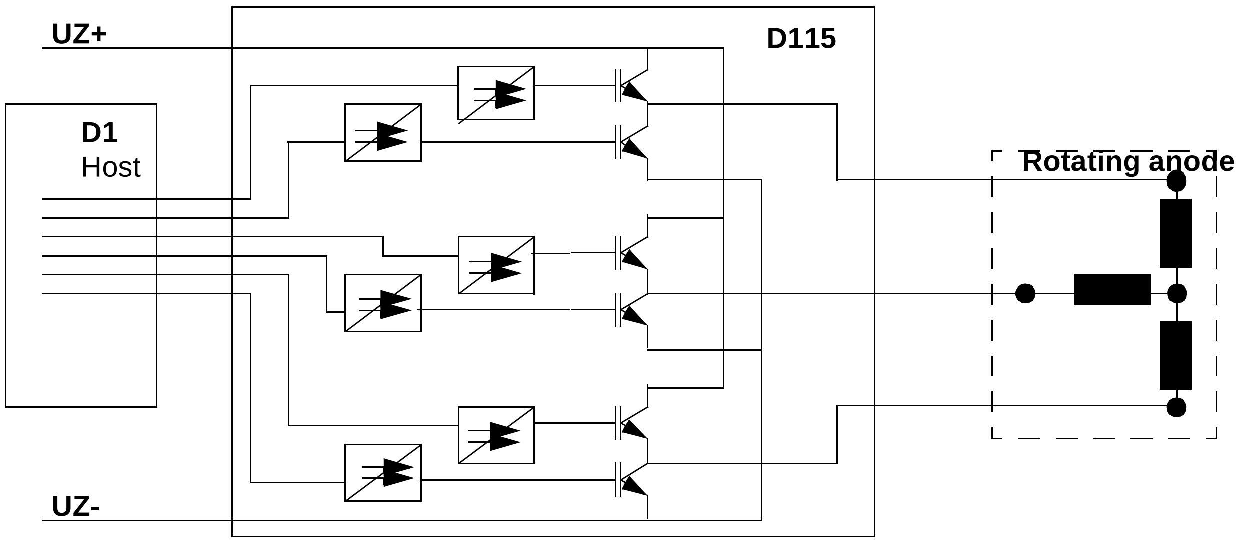
The controller for the filament and the tube current respectively and the half-bridge inverter of the filament circuit are located on the board D21. The setpoint values for the filament are transmitted by the host board D1 to the generator processor (MCB). The filament current is controlled without radiation. For this purpose the resonance current is measured by a transformer at the output of the filament inverter. After rectification of the resonance current, the actual value of the filament current (rms value) is available for the control and for monitoring. The control signal for the filament inverter, which lies in a frequency range of 20 to 43 KHz, is derived from the comparison of the actual filament current with the setpoint filament current. If radiation is switched on, the system switches over to tube current control. The tube current actual value is derived from the N-IROE-ACT and P-IROE-ACT signals from the Powerphos. The tube current actual value is compared with the tube current setpoint transmitted by the generator processor, so that the control signal for the inverter is generated. In the case of an error the control signals for the filament inverter are blocked, for example if the maximum filament current is exceeded, or overcurrent is determined in the inverter.
The filament current is adjusted by the "Generator learning" service software function.
The small or the large focus is selected corresponding to the operating mode by focus relays.

Rotating anode control

The rotating anode of the Powermobil is controlled by the starter D115. On radiation request from the host the rotating anode is accelerated to the nominal speed. During radiation the rotating anode is boosted cyclically and braked at the end of radiation.



The starter D115 converts the direct voltage delivered by the DC bus circuit into a three-phase alternating voltage. This inverter is designed as three-phase bridge circuit.



The host board D1 delivers the control signals for the starter, corresponding to the operating mode. The three-phase current for the drive as well as direct current for decelerating the rotating anode are generated by the activation of the transistors.

VIDEOMED-DC television system

Overview

The television system in the POERMOBIL is designated VIDEOMED-DC. The TV system is of the same construction as the TV systems in the SIREMOBIL-Compact and ISO-C, except for adaptation to the DCM mode. All stages are accommodated on a PC board, except for the power supply, which is installed in the C-arm. In the case of an error the complete TV board is replaced. Since the VID-DC is a self-adjusting system, no adjustments of the camera electronics are necessary.

The VID-DC

- is a normal resolution CCD TV system corresponding to the CCIR (625 lines / 50 Hz) or EIA standard (525 lines / 60 Hz)
- delivers a standardized output signal of 1Vpp across a terminating resistor of 75 ohms. The vertical synchronization corresponds to 50 Hz or 60 Hz respectively
- generates an actual value for the dose rate control and the automatic gain control which is derived from the video signal
- is a self-calibrating and self-testing TV system
- is CPU controlled.

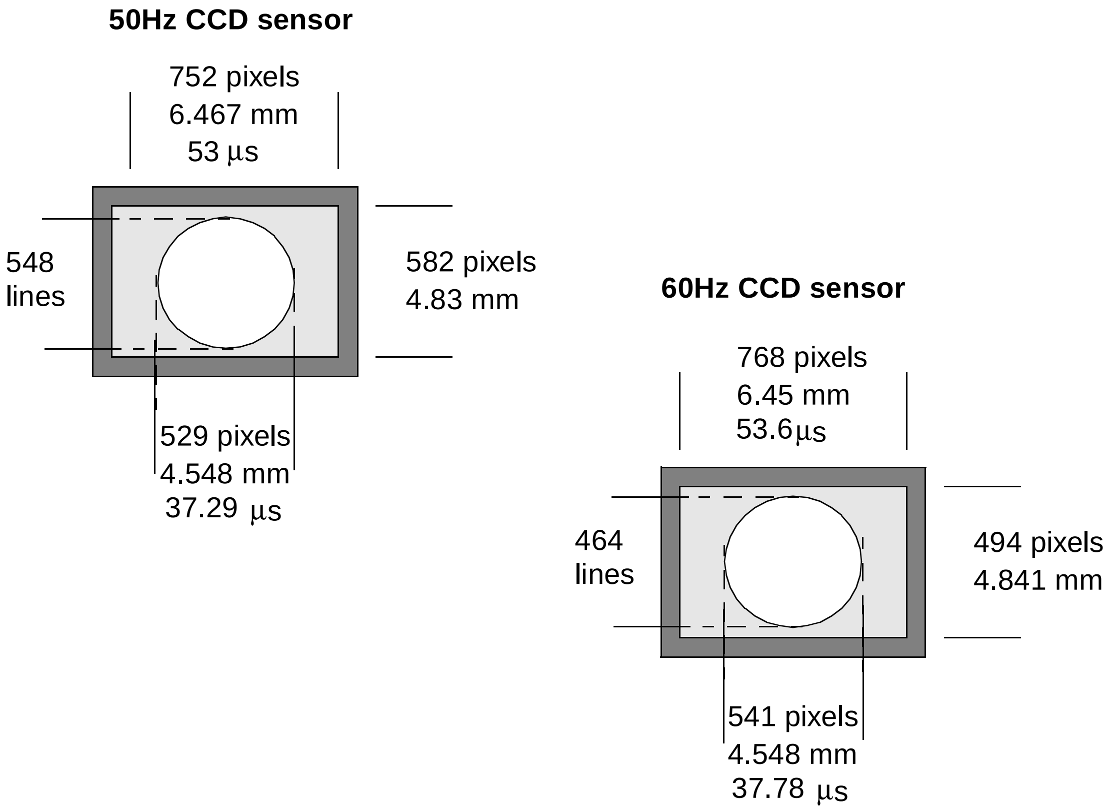
Optical system

The VID-DC is adapted to the image intensifier via an optical system with manually adjustable iris diaphragm.

The optical sharpness can be adjusted by an adjustment ring. The optical system is integrated in a rotatable mechanism, so that the entire TV unit can be rotated. The angle of rotation is $\pm$ 220°($\pm$ 2°) and is displayed on the control panel. Positioning is by the host computer and the motor control on board D1.

CCD sensor

The CCD sensor converts the optical image signal coming from the image intensifier into an electronic image signal.



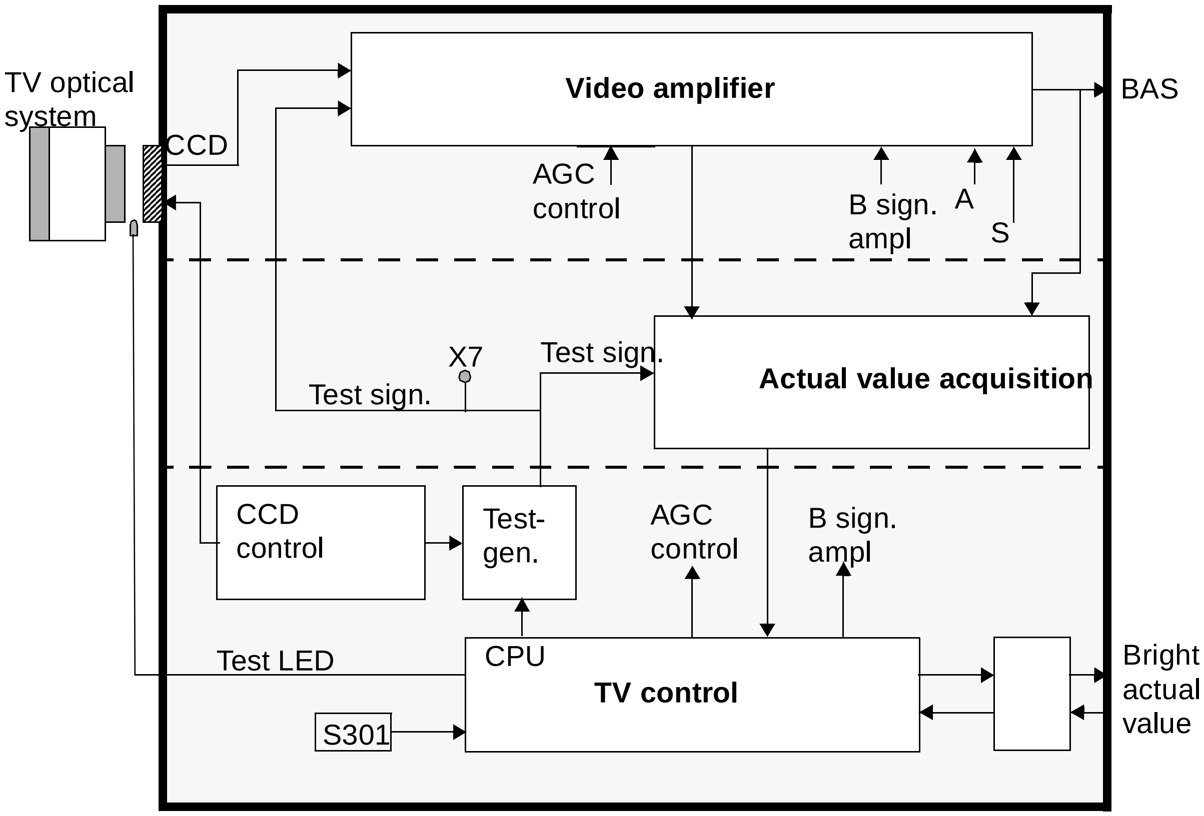
The CCD sensor used in the VID-DC works according to the interline transfer principle. The image which is projected through the optical system onto the CCD sensor generates charges in the individual pixels of the CCD sensor which correspond to the illuminance of the relevant pixel. These pixel charges are taken over into the corresponding read-out register during the V or H blanking time and transported to the video output of the CCD sensor. Voltage drops corresponding to the charges arise there across a resistor. The image signal results from the sum of the individual voltage values.

Two different CCD sensors are used, since different matrix sizes (see illustration) are required for 50 Hz and 60 Hz. Thus two different hardware versions of the VID-DC are used.

To check the functionality of the CCD sensor, the CCD sensor can be illuminated with a test LED and an image signal can thus be generated.

The CCD sensor is cooled by a copper stamp, which is glued directly onto the CCD sensor. The sensor temperature should not exceed a value of 42°C, since otherwise the image quality can be impaired.

Block circuit diagram



The electronics of the VID-DC consist of three main modules:

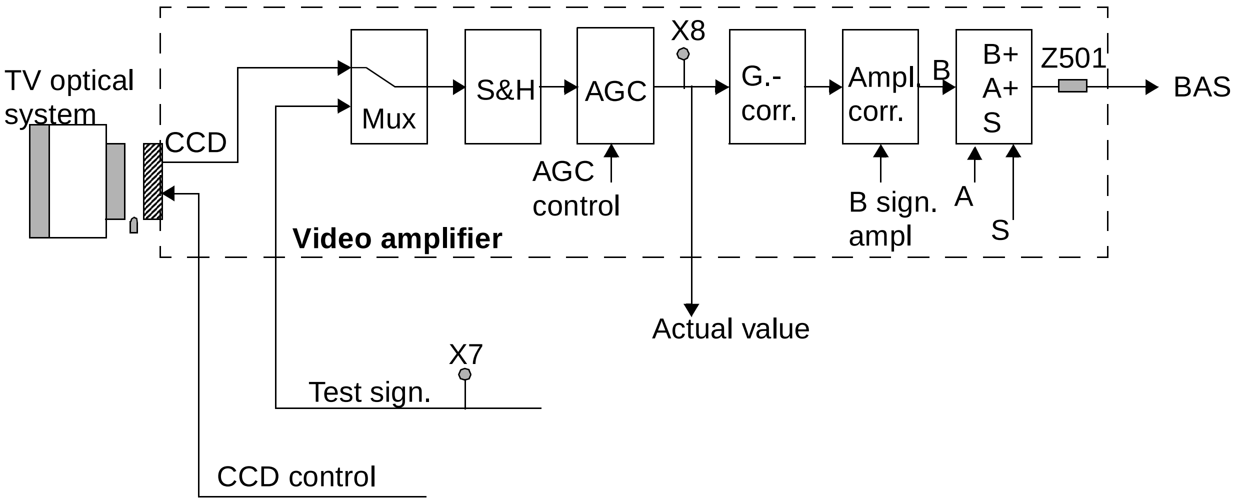
- the video amplifier
- the actual value acquisition and
- the TV control

The video amplifier generates from the analog video signal delivered by the CCD sensor a BAS (composite video) signal of 1Vpp across a 75 ohm terminating resistor.

The actual value acquisition delivers an actual value for dose rate control and AGC.

The TV control delivers the control signals for the TV function stages and transmits the "Bright actual value" through the serial interface to the generator.
The communication between host computer and TV system also takes place through the serial interface.

Video amplifier



Input multiplexer

The video signal from the CCD sensor is switched to the video amplifier through the input multiplexer. During the self-test phase after power ON, the multiplexer selects a test signal which is generated in the TV control. For service purposes this test signal can also be programmed using the service switch S301.

S&H stage

The following Sample & Hold stage samples the video signal in the pixel clock frequency so that a continuous video signal results.

AGC control element

The AGC controls the gain of the video amplifier. If the brightness control of the Powermobil can no longer correct the video signal, the automatic gain control of the host computer is enabled. The control dynamic range of the AGC is 16dB.
The higher the gain, the lower is the signal-to-noise ratio, since the interference signal portion of the video signal is also amplified. The image quality is worsened by this depending upon the gain factor. The control signal for the AGC is generated through the actual value acquisition and the AGC control circuit in the TV control.
The CPU of the TV control compares the digitized value of the actual value acquisition with a stored setpoint and thus generates a digital AGC control value. This control value is then converted into an analog signal and fed to the AGC control element in the video amplifier. As long as the dose rate control does not reach its maximum value, the AGC retains a fixed gain. The actual value for the actual value acquisition is decoupled at the output of the AGC.

Gamma correction

To increase the detail contrast for signal components with low amplitude, the video amplifier of the VID-DC contains a gamma correction stage. This stage has a non-linear gain. For the video signal components with low amplitude, the gain is higher than for high signal amplitude values. The gamma correction compensates in a certain manner the non-linear characteristic of the picture tube in the monitor. In this way the contrast behavior and thus the image quality is improved. A fixed gamma of 0.7 results in the VID-DC.

Amplitude correction

In this stage the video signal amplitude is corrected during the self-adjustment phase after power ON, so that a video signal component of 650 mVpp results in the BAS signal.
The test signal is used as measuring signal.

BAS mixing stage

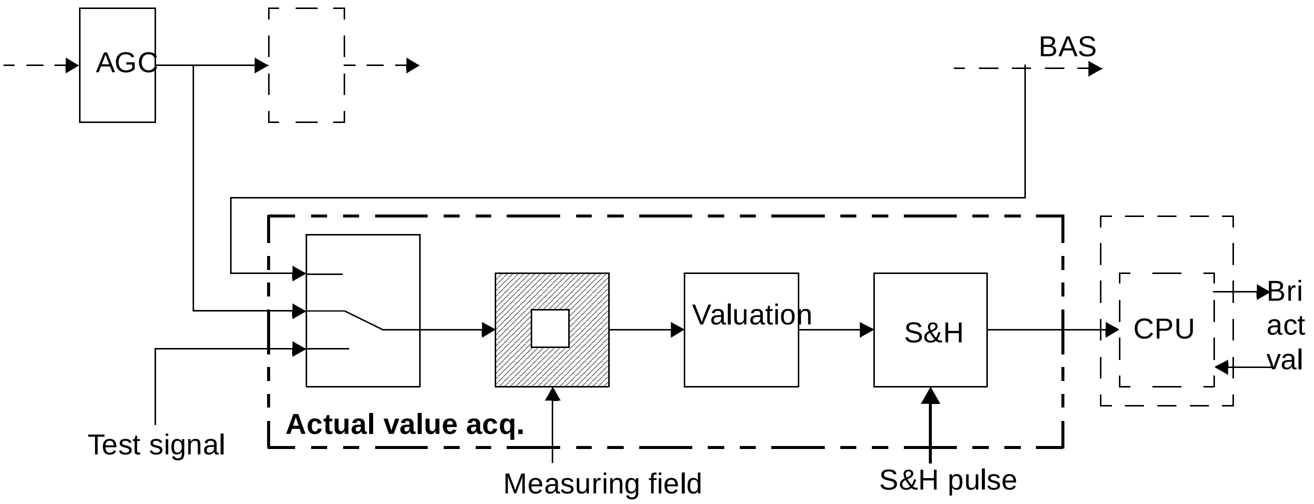
Video signal, H and V blanking signal and the synchronizing signal are combined in the mixing stage, so that the BAS signal results.

The amplitude values of the individual signal components are in this case:

Video signal	650 mVpp
Pedestal	50 mVpp
Synchronization signal	300 mVpp

A standard BAS signal of 1 Vpp across a terminating resistor of 75 ohms results from this.

Actual value acquisition



To generate an actual value for the dose rate control and for the AGC, the video signal is decoupled from the video channel after the AGC control element and switched to actual value acquisition through a multiplexer. The multiplexer can also select the test signal or the BAS signal respectively for test and adjustment purposes.

Measuring field acquisition

Since the important image parts are in the center of the image, the outer image region is blanked for acquisition of the actual value. A rectangular measuring field is used for this. Only the video signal components which lie inside the measuring field are passed on for generating the actual value and can influence the dose rate control or the AGC.

Valuation

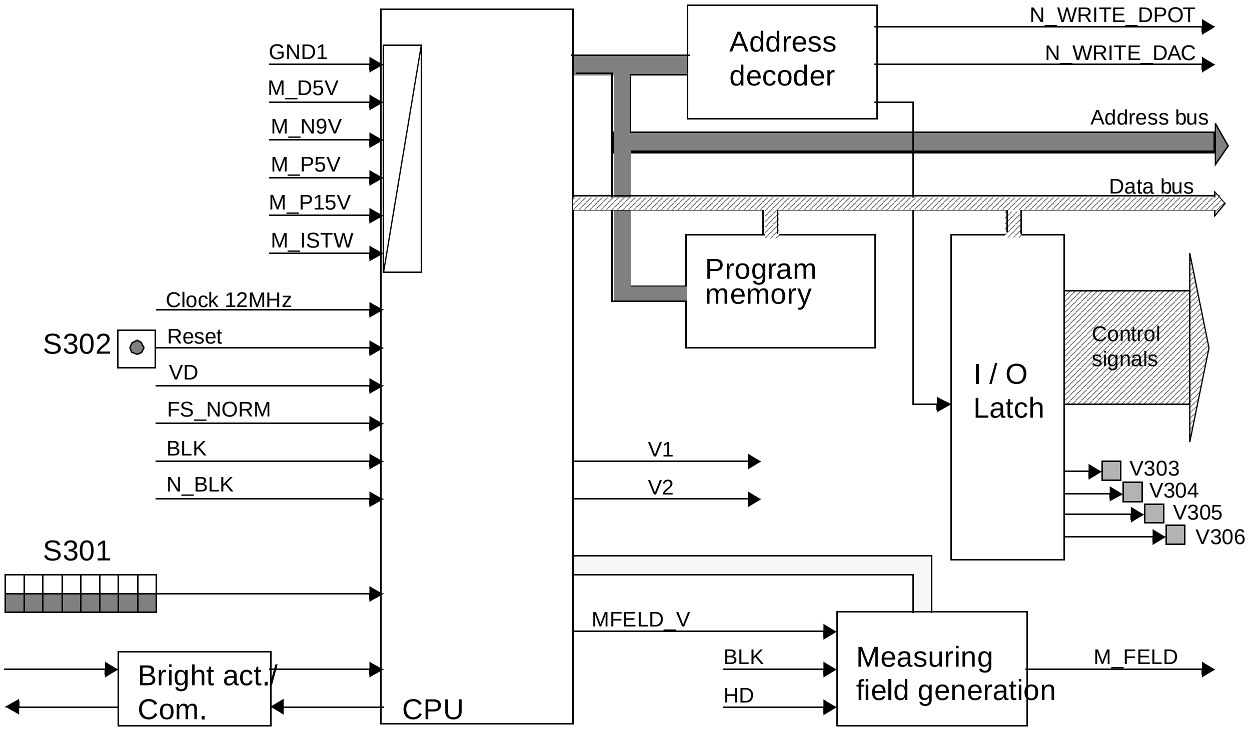
Since the actual value must be a direct voltage value for the control systems, the direct voltage mean value of the video signal is determined in the valuation stage with an integrator circuit. There is only one type of valuation, average evaluation in the SIREMOBIL-Compact.

S&H stage

The direct voltage mean value thus generated is stored in the following S&H stage. Since the sample clock corresponds to the vertical clock, the actual value is updated every 20ms (50 Hz) or 16.66 ms (60 Hz) respectively. This analog actual value is fed to an A/D input of the control CPU and converted into a digital 8 bit value.
The digital "Brightness actual value" is fed to the AGC and through the serial interface to the dose rate control.

NOTE	**If the actual value acquisition or the bright actual value is faulty, radiation is blocked in closed loop control.**

Television control



A CPU of the type SAB80C535 is used for controlling the TV functions.
The control signals are output to the individual stages through the I/O latch.
The TV system software is stored in the program memory.

Measuring field generation

The rectangular measuring field used in the VID-DC is stored. Different measuring fields corresponding to 50 Hz or 60 Hz are addressed by the CPU and passed on to the actual value acquisition.

Serial interface

The serial interface serves for transmitting the brightness actual value and the communication with the host computer. The "Brightness actual value" is transmitted in the V clock to the generator. The communication between host and TV system is enabled between the individual bright actual telegrams. Physically the serial interface corresponds to a 20 mA current loop.

Analog inputs

The CPU has several analog inputs or internal A/D converters. Supply voltages for the power-up test are converted through these inputs. In addition, the analog actual value from the actual value acquisition is converted into a digital value, the "Brightness actual value".

Service switch S301

Various test or control signals can be selected on the service switch S301. Thus for example:

S301	.1	.2	.3	.4	.5	.6	.7	.8
Normal position	off	off	off	off	off	off	off	off
Measuring field 1		not in operation						
Measuring field 2		not in operation						
AGC request	x	x	on	x	x	x	x	x
AGC stop	x	x	x	on	x	x	x	x
Radiation ON	x	x	x	x	on	x	x	x
AGC control element test signal	x	x	x	x	x	on	off	x
Actual value acquisition test signal	x	x	x	x	x	x	on	x
Test LED EIN	x	x	x	x	x	x	x	on

X switch position not relevant

TV initialization

The following tests and self-adjustments run in the initialization phase after power ON:

- Checking the supply voltages
- Adjustment of the actual value acquisition
- Adjustment of the manual gain
- Adjustment of the video signal in the BAS signal
- Adjustment of the black value in the BAS signal

Once the initialization is completed, the "Brightness actual value" is transmitted to the generator.

Booting the TV system lasts approx. 30 s.

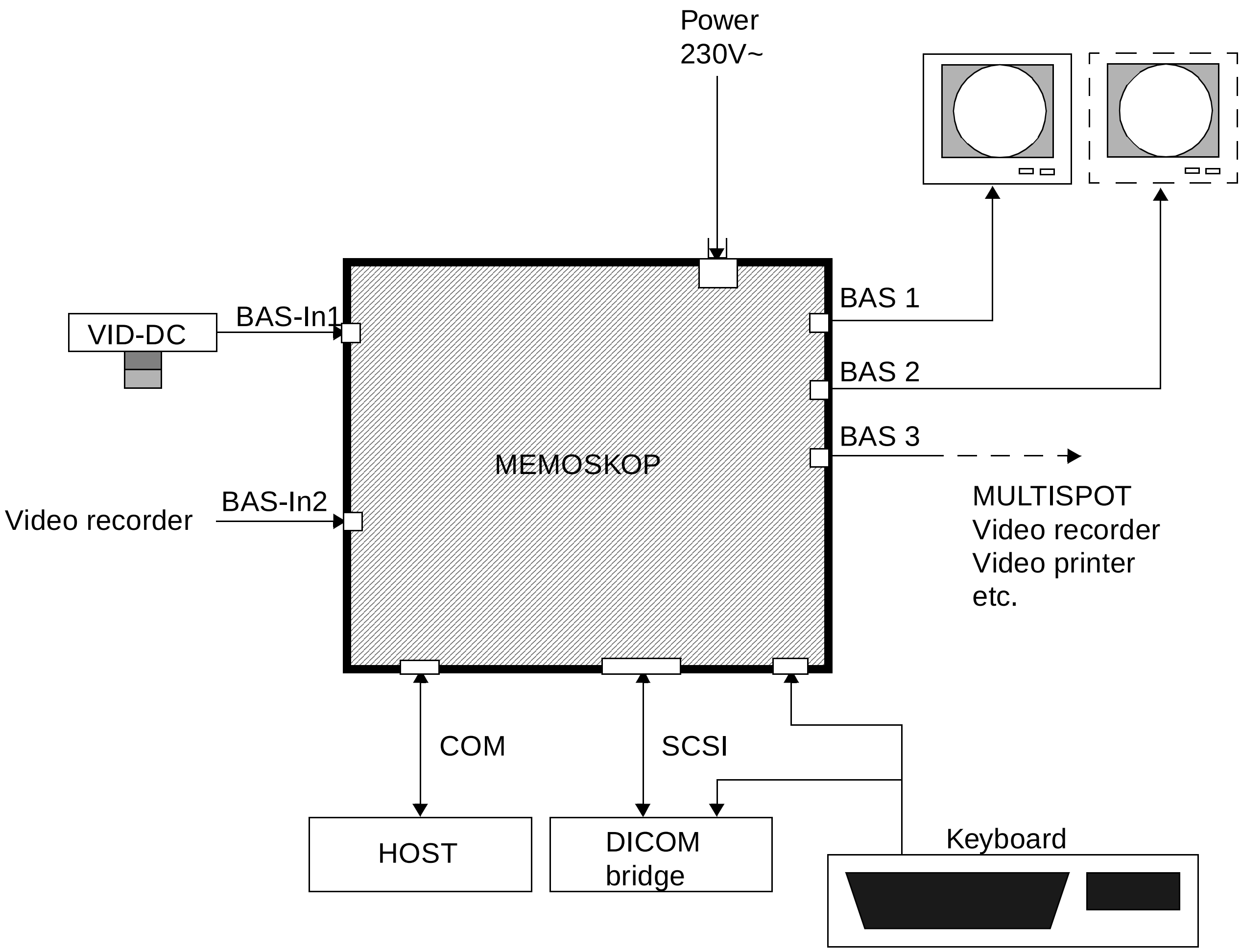
After the initialization, only the actual value acquisition is still checked every minute.
If radiation is switched on during this time, the test is broken off.

MEMOSKOP

The frames which are delivered by the television system are stored in the image memory of the POWERMOBIL, the MEMOSKOP-Fast.

There are two versions of the MEMOSKOP-Fast which differ only due to the storage capacity of 5000 or 10000 frames.

Cabling



Power supply

The MEMOSKOP is supplied with 230 V alternating voltage from the isolating transformer T1 independently of the available line voltage.

Communication

The communication between host computer and MEMOSKOP is conducted through a serial interface. This interface is physically a 20 mA current loop.
Time-critical signals, such as memory START from the host and the acknowledge signal ACQUISITION from the memory are conducted through separate 20 mA interfaces.

BAS input1

The BAS standard signal, 1 Vpp, 50 Hz / 60 Hz coming from the TV system is connected at the "VIDEO-IN" connector. In the MEMOSKOP the BAS signal is terminated with 75 ohms.

BAS output Mon1 / Mon2

The BAS outputs for monitor 1 and monitor 2 deliver a BAS signal with 1 Vpp across 75 ohms and a vertical frequency which, according to version, can be 50 Hz, 60 Hz, 100 Hz or 120 Hz. Monitor1 displays the current FL image or the LIH image. The memory image is displayed on monitor 2.

BAS output3

A BAS signal of 1 Vpp across 75 ohms with a vertical frequency of 50 Hz or 60 Hz is available at the BAS output 4 for video components such as multiformat camera, video printer, video recorder etc.

BAS input2 for video recorder

The video signal of the video recorder can be displayed through this BAS input.

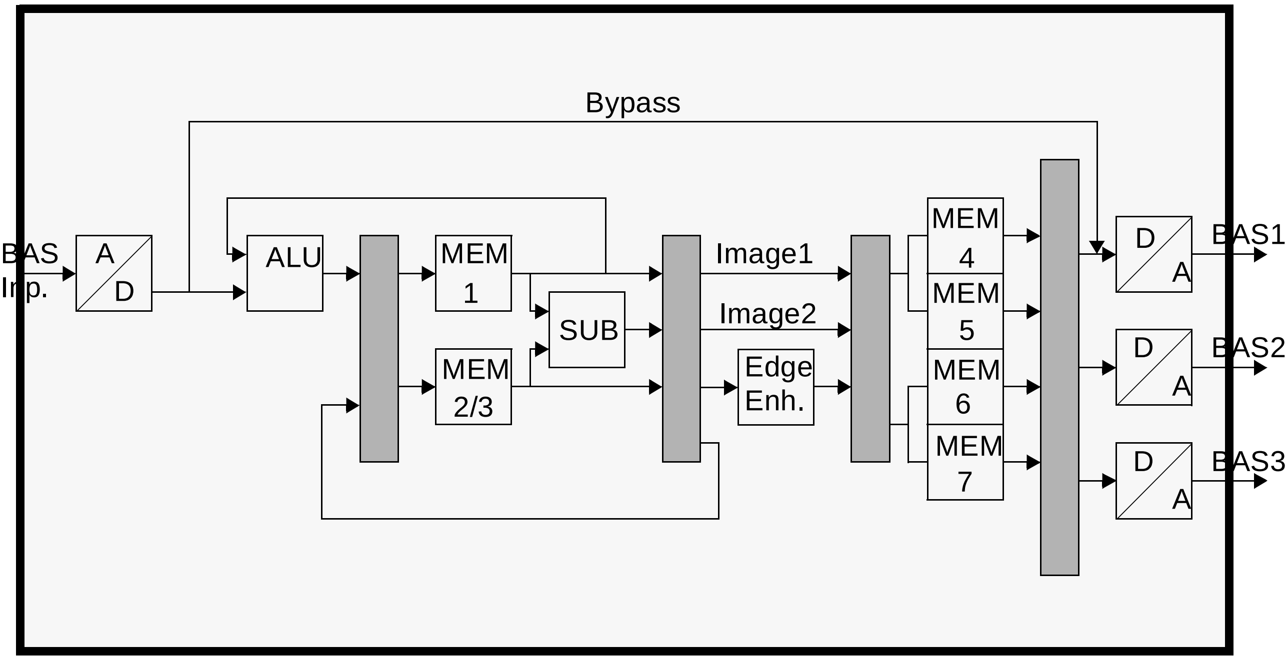
Keyboard connection

A keyboard (optional) for entering patient data is connected at the MEMOSKOP "KEYBOARD" connector through a RS232 interface. Different keyboards corresponding to the national character sets and the memory version are available.

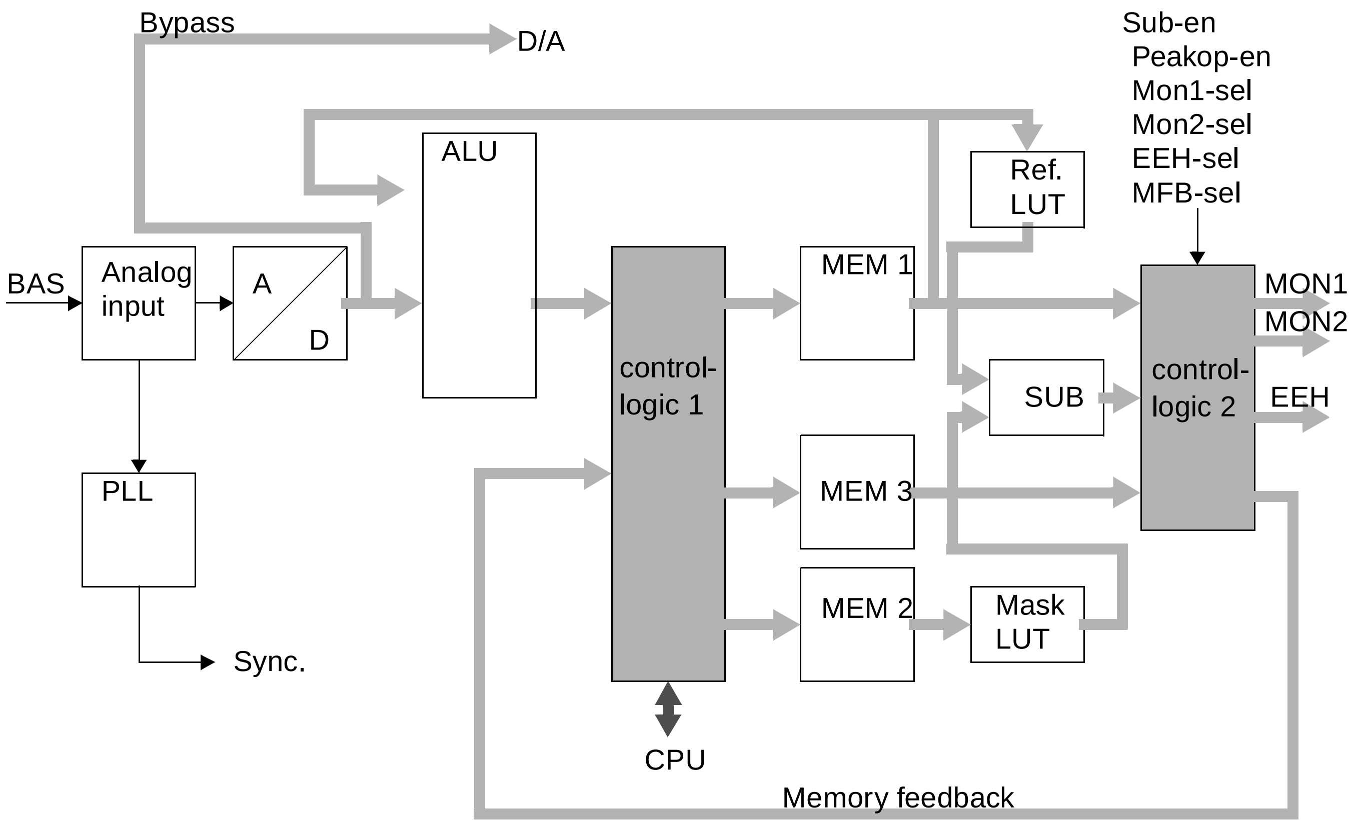
DICOM bridge

Images which are stored on the MEMOSKOP hard disk can be forwarded to the hospital network in the DICOM format using the DICOM bridge.

MEMOSKOP Fast block circuit diagram



After the analog BAS input signal has been converted into digital pixels of 8 bits with the A/D converter, they can be calculated with an ALU (arithmetic logic unit). The ALU serves for noise reduction and for motion detection. The following MEM1 memory is the working memory of the ALU. The image data stored here are used for the calculation in the ALU. The calculated image data of the finished memory images are stored in the frame memories MEM 2 and 3. The following stage, edge enhancement, serves for enhancing the contrast of the object edges. The processed image data of the current FL image are stored in the field memories MEM4 and MEM5. In this case the vertical frequency of 50 Hz (write) is converted to 100 Hz (read) or from 60 Hz to 120 Hz respectively. MEM6 and MEM7 convert the memory image for monitor 2. The digital image data are converted back into an analog output signal with the following D/A converters.



Analog input

The BAS signal of 1 Vpp generated in the TV system is terminated with 75 ohms in the analog input amplifier. The synchronization signal component of the BAS signal is separated in the input amplifier and forwarded to the PLL for synchronization of the memory. The B signal is also adapted here to the input range of the A/D converter. The blanking and synchronization component of the BAS signal are cut off, so that only the B signal component is digitally converted.

PLL

The PLL (phase locked loop) synchronizes the internal clock generator with the synchronization signal separated from the BAS signal and generates from this clock and synchronization signals for the memory. If no input signal is present, the memory is synchronized with an internally generated clock signal.

A/D converter

The A/D converter converts the analog B signal into an 8 bit value. 256 scales of gray result from this.

Control logics 1

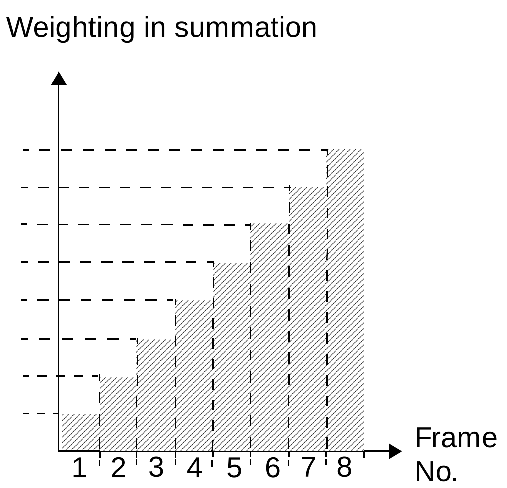
The image data are smoothed by this logical stage and stored corresponding to the selection (FL, LIH or memory image) in MEM1, MEM2 or MEM3.

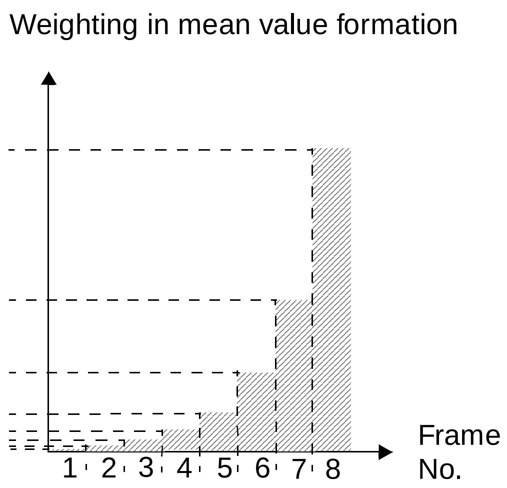
ALU (noise reduction)

The ALU (arithmetic logic unit) is an arithmetic logic unit for calculating the image data for moving weighted mean value formation, summation and motion detection.

The moving weighted mean value formation and the summation are image integration modes which serve for noise reduction. The image information of the output image results from the integration of several frames. The number of the frames to be integrated can be selected on the control panel. Integration factors are: 1 (no integration) 2, 4, 8 and 16. If a high integration factor is selected, no movement of the examined object may occur, since otherwise blurring of the image would result due to the temporal integration.

Moving weighted mean value formation is used in normal fluoroscopy, whereas the summation is used in the DR mode. The difference between the two integration types is that with moving weighted mean value formation the information content of the individual frames decreases, whereas the weighting remains the same in the summation.





ALU (motion detector)

Since image quality problems (smearing of the image information) result from the integration with moving objects, the motion detector function can be selected on the control panel. In the ALU the pixel value of the stored frame is subtracted in this case from the pixel value of the new frame. If a difference value lying above a programmed threshold results from this, the noise reduction factor is reduced. The motion detector function is possible only in fluoroscopy.
Two motion detector stages can be selected in the POWERMOBIL.

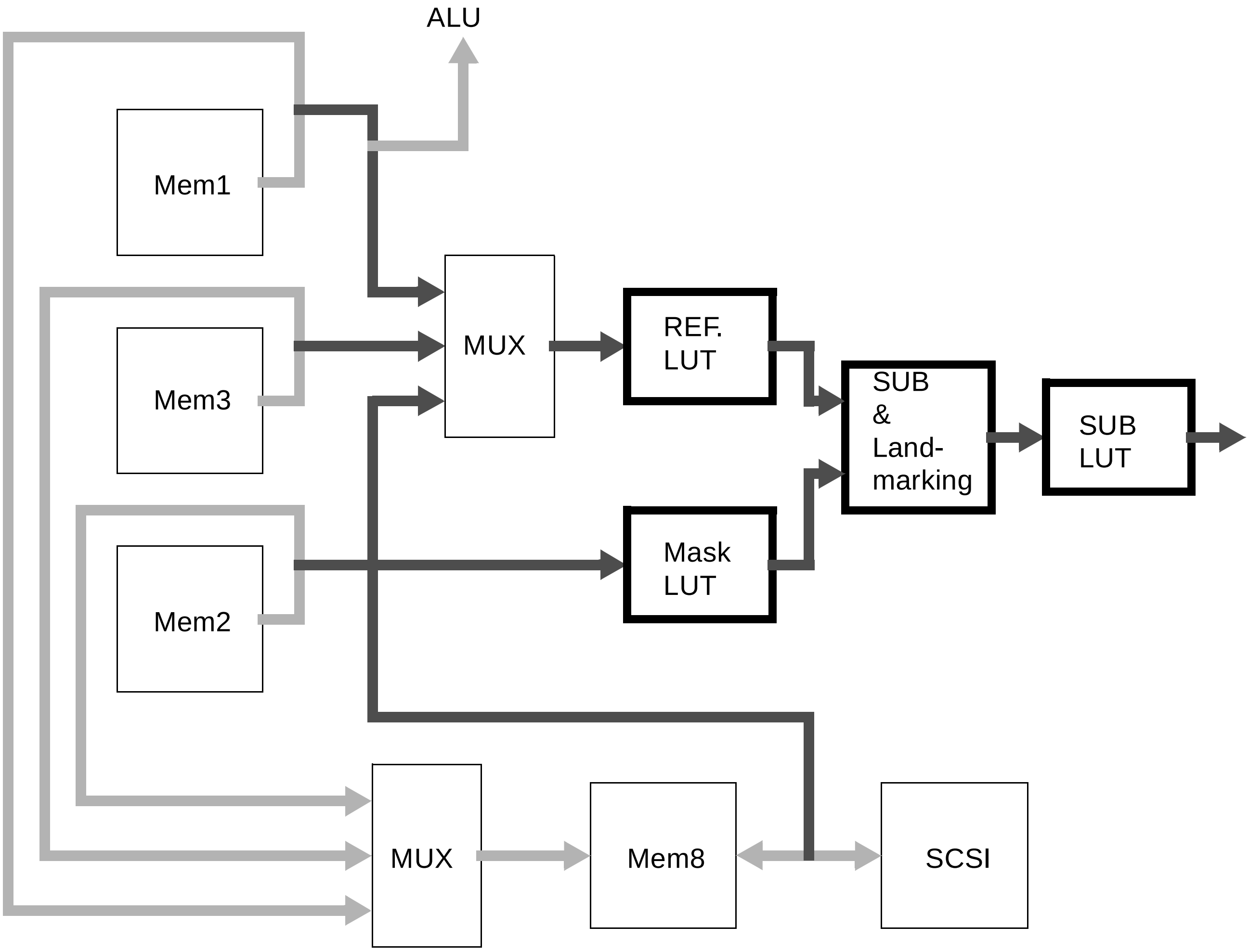
Memory 1

Memory1 is the working memory belonging to the ALU. This memory has a matrix of: 512*512*12

Memory 2 / 3

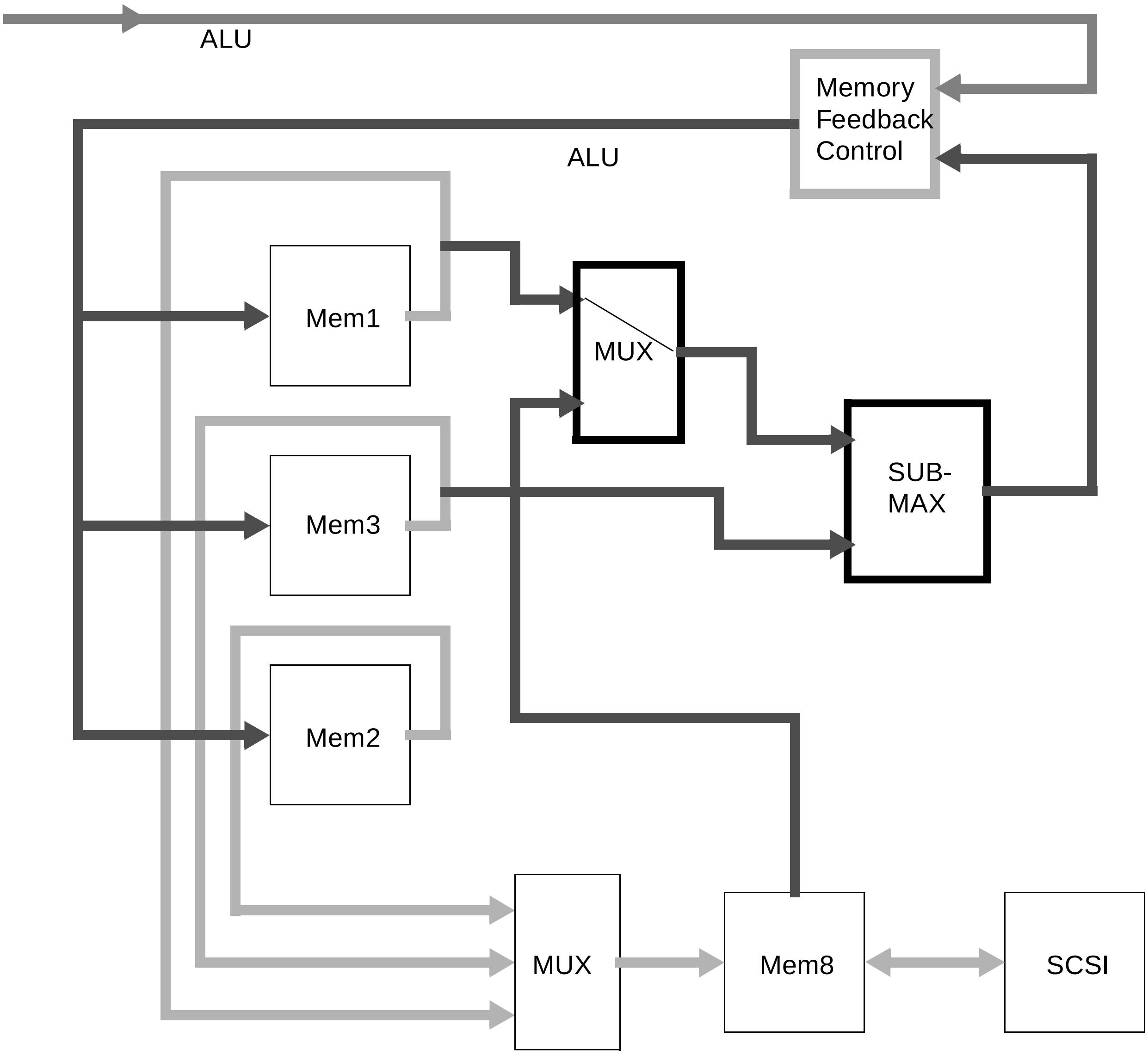
The memory images for monitor 2 are stored in memory 2 and 3. The memory matrix is 512*512*8. Two memory images can be displayed on one monitor using a split function (horizontal or vertical).

Subtraction



In MEMOSKOP SUB the "Mask" (plain exposure) is stored in memory 2 and the filled image (exposure with contrast medium) in memory 1 or memory 3. These two images are subtracted after adaptation using LUTs, so that only the differences between the two frames is retained as result. The mask and the filled image differ in the region of the contrast medium run. This is displayed as final result. To change the image contrast of the subtraction image, a window can be generated via the SUB-LUT. The pixel values which lie inside the window are adapted here to the input range of the D/A converter.

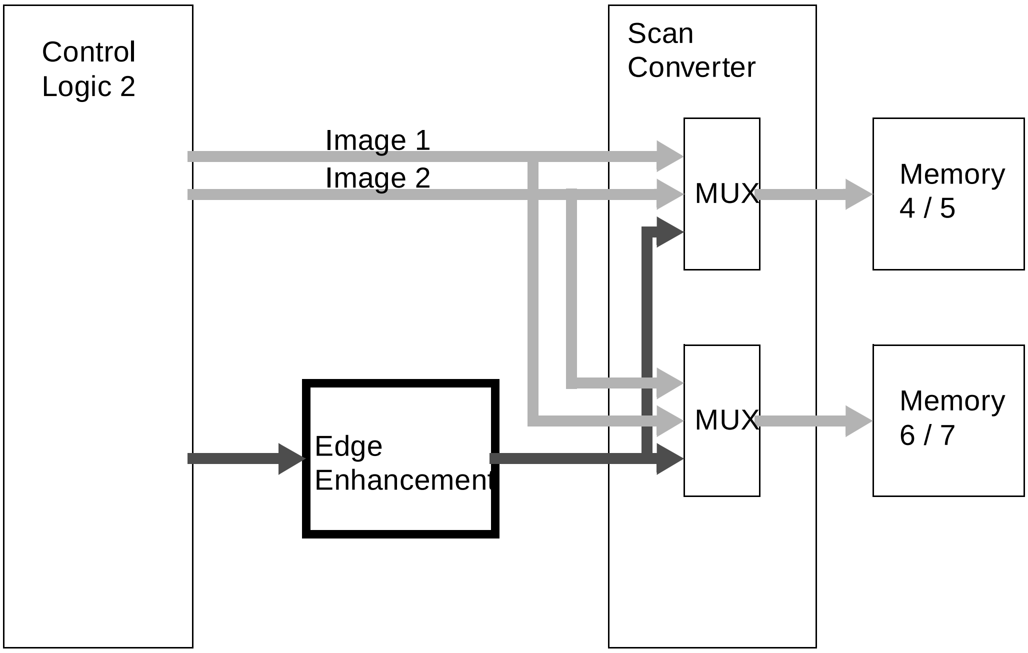
SUB-MAX function (maximum opacification)



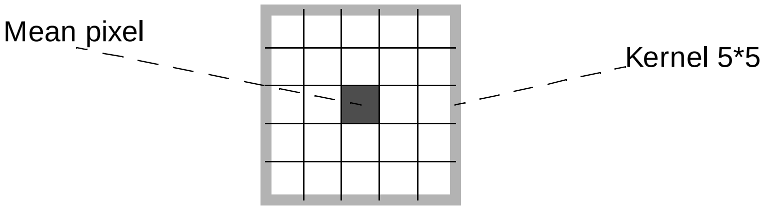
The **SUB-MAX** function serves for displaying the entire contrast medium run of a subtraction scene. For this purpose the lowest value of the pixels is stored. If for example the value of a certain pixel in the new frame is smaller than in the stored frame, the stored value is replaced by the new low value. If the pixel value in the new frame is larger, the lower value of the older stored frame is retained. A memory image in which the lowest pixel values are stored from all frames result from this type of evaluation of all frames of a subtraction scene. The entire contrast medium run is thus displayed in the last image.

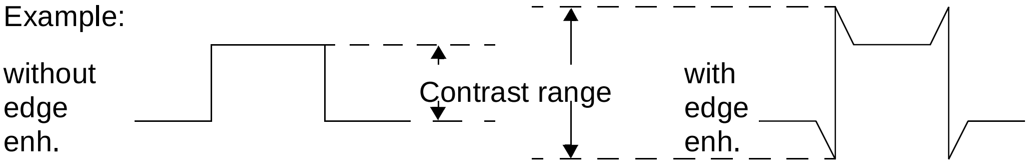
In the SUB-MAX function, the image data from memory 1, memory 3 are processed.

Edge enhancement



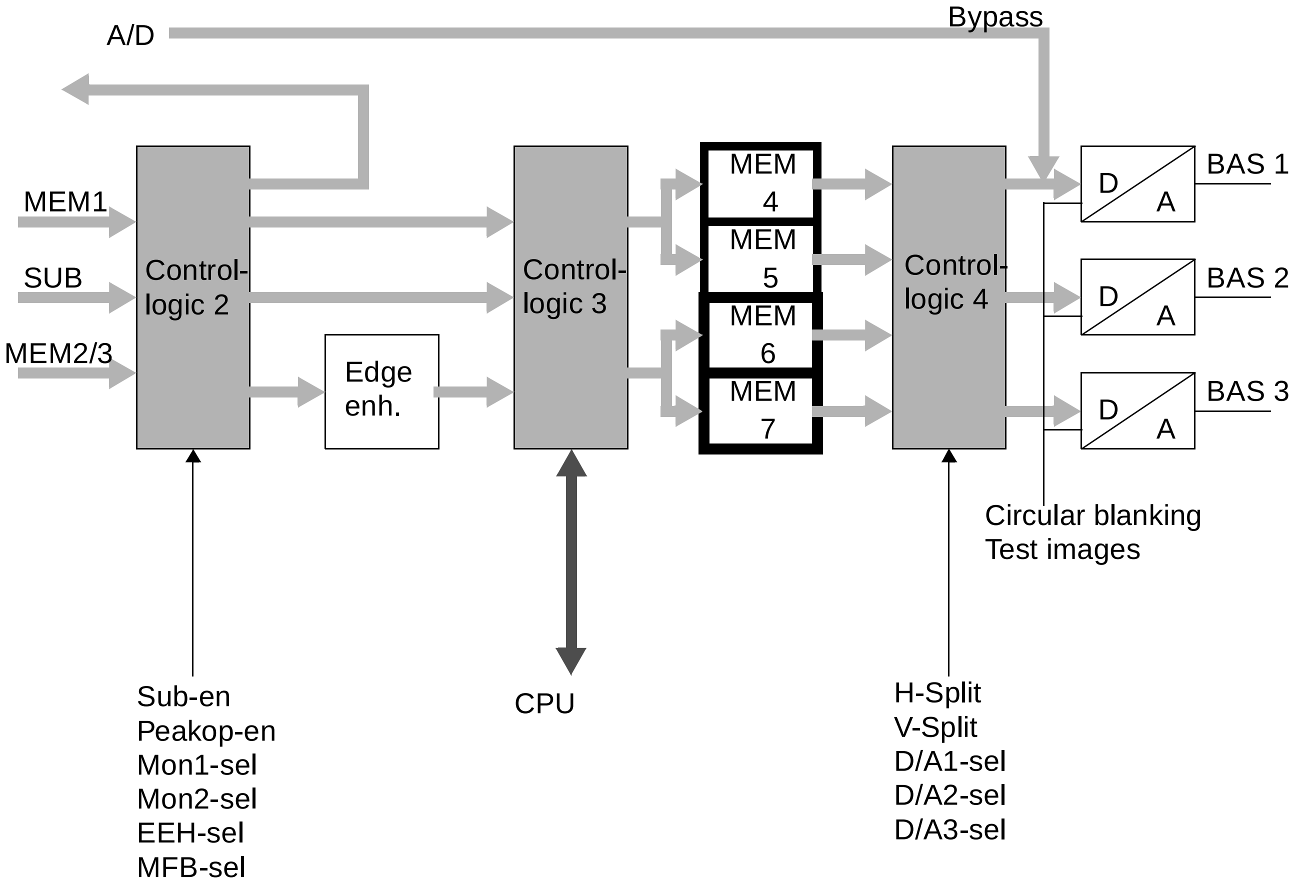
To increase the contrast impression, the values of the pixels at the image edges can be changed using digital spatial frequency filtration. To calculate the new pixel value for the average pixel, the pixel values of the surroundings are also included.
In the MEMOSKOP a kernel with a matrix of 5*5 is used.





MEM2/3

The memory images for monitor 2 are stored in memory 2 and 3. The memory matrix it 512*512*8. Two memory images can be displayed on one monitor using a split function (horizontal or vertical) here.



Control logic 2

The image data are forwarded through this directly, or through the filter for edge enhancement.

Control logic 3

The image data are passed onto the display memory through this logic stage.

MEM4, MEM5, MEM6, MEM7

MEM4 to MEM7 are memories for one field each. The memory frame for monitor 1 is located in MEM4 and Mem5, the memory frame for monitor 2 in MEM6 and MEM7.
The memories are divided into two areas. In this case the image data of a field are written into one memory half with 50 Hz or 60 Hz V clock frequency respectively whereas the second memory half is read out with double V clock frequency. The image data of the second field are then written into the second memory half with normal V clock frequency and the first memory half is read out with double V clock frequency. The same process also applies for MEM6 and MEM7.

Control logic 4

This logic stage forwards the image data to the D/A converters.

D/A converters

The three D/A converters convert the digital image information back into an analog video signal. The blanking and synchronization signal are also mixed in through special inputs. A circular blanking signal is generated for this in the MEMOSKOP. The text data are also mixed into the video signal here.

Hard disk control

The buffer memories Mem8A and Mem8B are used for intermediate storage of the frames which should be stored on the hard disk. These are two banks which are equipped with SDRAMs and can in each case temporarily store 4 frames.

4x4 collage

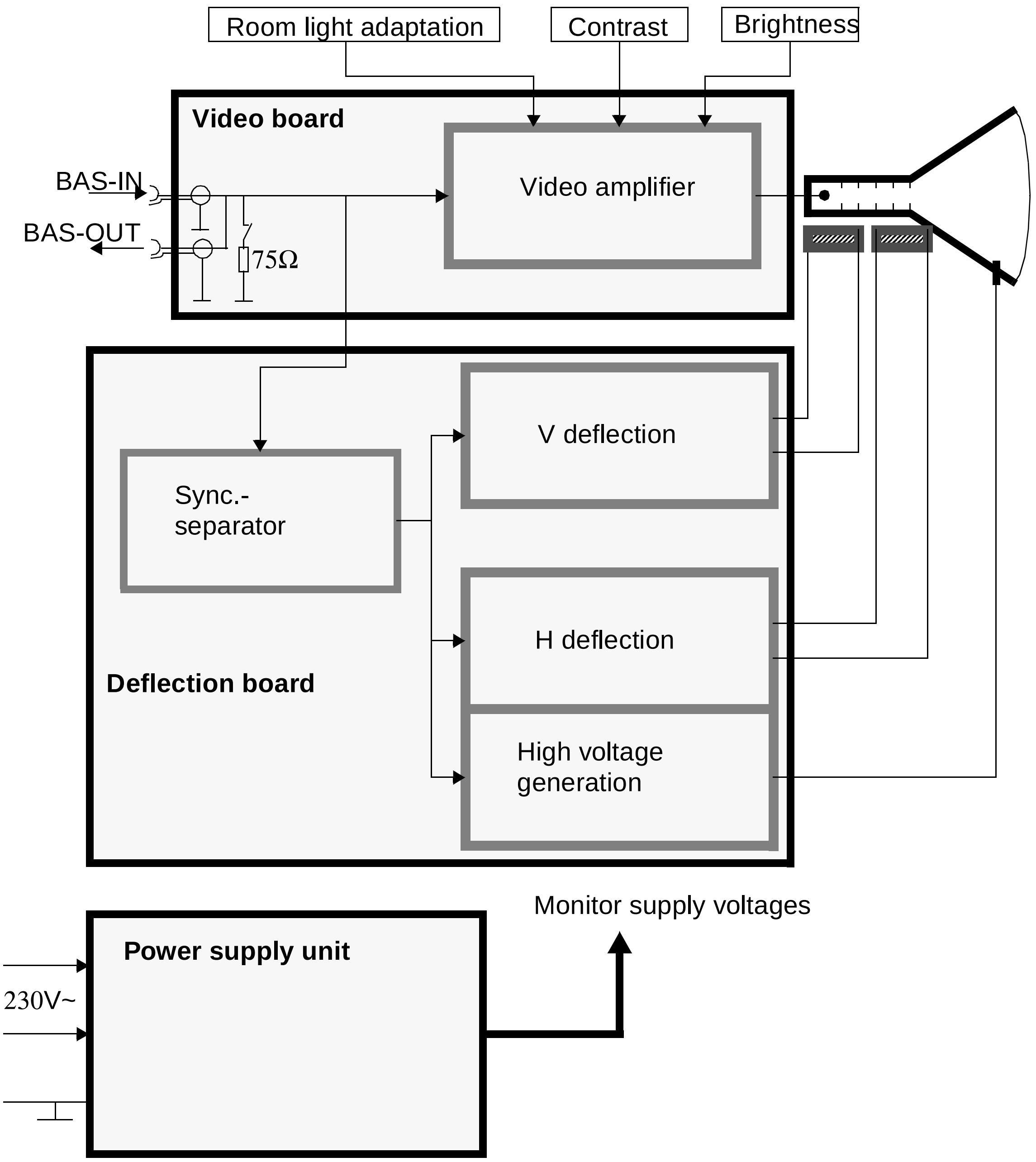
For this first 16 images are read from the hard disk and each 4th pixel and each 4th line of the first field of the read images is stored in the image memory. In this way the images are reduced in size to 1/4 of the horizontal and 1/4 of the vertical image amplitude. In this way a total of 16 images can be displayed simultaneously.

Zoom and roaming

If the zoom memory function is activated, the lines and pixels of a frame are displayed in each case twice after one another. The zoomed image can be shifted up, down, to the right and to the left with the arrow keys.

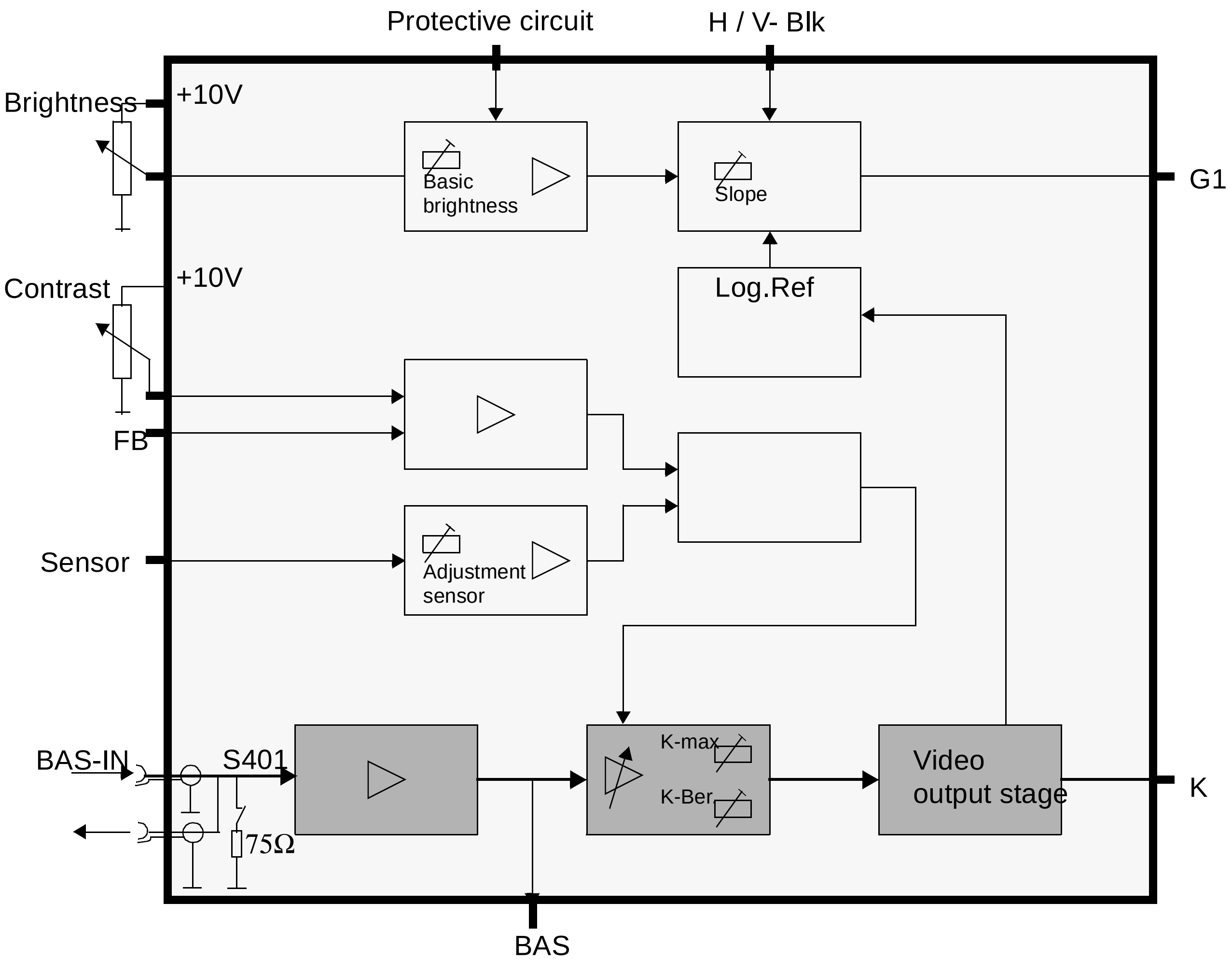
SIMOMED 90 N

Overview



There are three main boards in the SIMOMED monitor, the video amplifier board, the deflection board and the power supply unit board. Monitor service is at board level.
The supply voltages for the monitor are generated on the power supply board.
All necessary stages for the horizontal and vertical deflection of the electron beam in the picture tube are located on the deflection board. The high voltage for the picture tube is also generated on this board.
The video amplifier amplifies the BAS signal, which is delivered by the image memories with an amplitude of 1 Vpp.

Video board

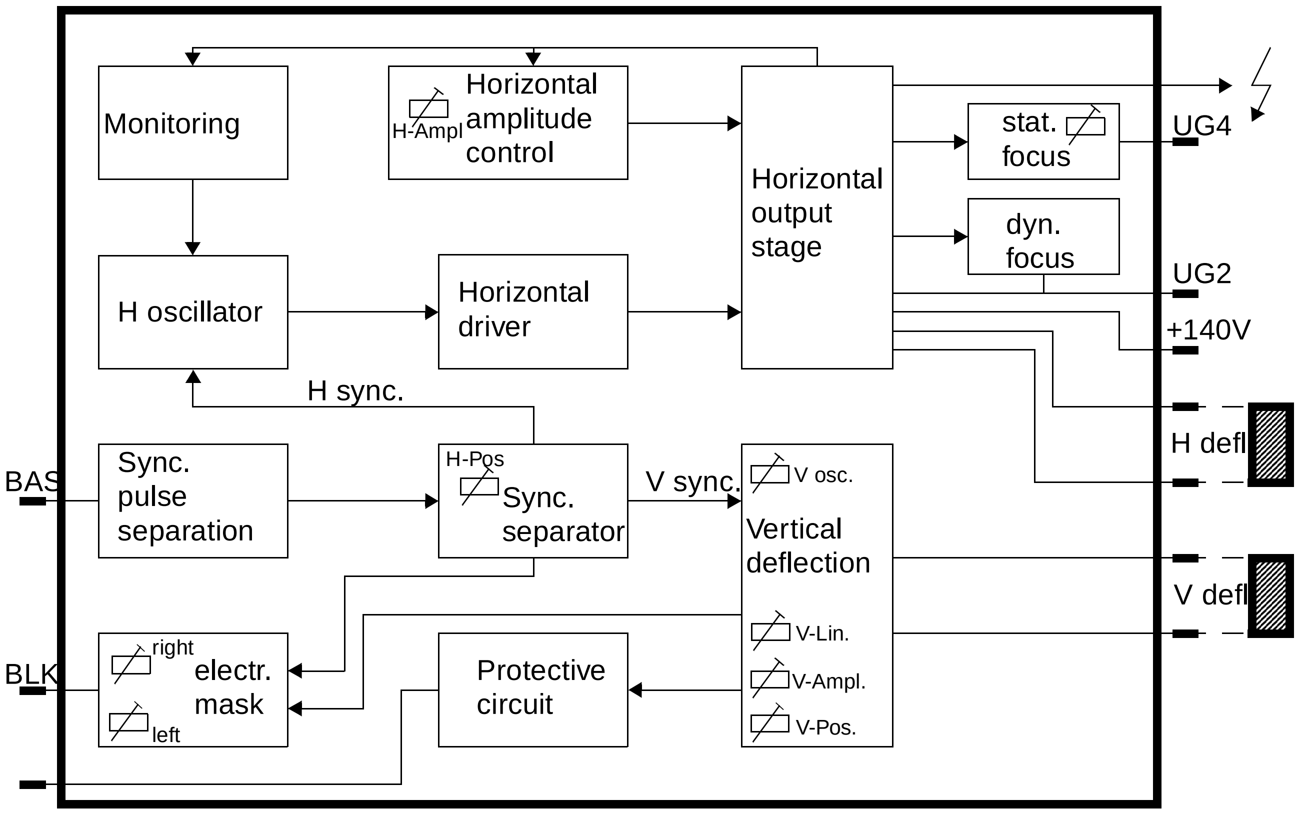


The following functions are implemented on the video board:

- Amplifying the video signal to the cathode level required for the picture tube
- Controlling the contrast
- Controlling the brightness
- Black value clamping (with/without)

The BAS signal from the image memories comes through the BAS input socket to the video board and can be terminated here with 75 ohms. If the BAS signal is passed on, it can be looped through over the BAS output socket. In this case the terminating resistor must be switched off with S401. The video signal is amplified to cathode potential with the amplifier stages. The gain factor can be changed with the contrast controls and the sensor for room brightness adaptation. The brightness control, which controls the grid 1 voltage and thus the brightness of the picture tube, is also located on the video board. The BAS signal reaches AC- or DC-coupled (with/without black level clamping) the cathode of the picture tube through a video output stage.

Deflection board



The deflection board has the following functions:

- Vertical and horizontal deflection of the electron beam in the picture tube
- Generating the high voltage for the picture tube
- Generating the grid 2 and grid 4 voltage (focusing)
- Protective circuit for protecting the picture tube against burn-in on failure of the deflection
- Generating an electrical mask for blanking the video signal at the edge

Synchronization pulse separation

The horizontal and vertical synchronization pulses are separated from the BAS signal with a limiter circuit. The H and V synchronization pulses are then separated from one another, in order to control the H and V oscillator. If there is a lack of synchronization signal, the oscillators run on freely, so that failure of the deflection, and thus burning of the fluorescent layer of the picture tube can occur.

Vertical deflection

The vertical oscillator generates a frequency corresponding to the V synchronization, which is fed to the following integrator. This integrator generates a vertical frequency sawtooth current, which is fed to the vertical coil of the deflection unit through an output stage. The magnetic field of the V deflection coil deflects the electron beam in the picture tube in the vertical direction.

H oscillator

The H oscillator generates a horizontal frequency for actuating the horizontal output stage. The H oscillator is synchronized with the H synchronization pulse.

Horizontal output stage

A H frequency saw-tooth current for the H deflection coil of the deflection unit is generated in the H output stage. This results in the magnetic field which is necessary for deflecting the electron beam in the horizontal direction. The high voltage for the picture tube is also generated in the H output stage by transforming the horizontal flyback pulses. The voltages for the grids 2 and 4 of the picture tube (focusing the electron beam) are also generated here. The image width is controlled via the H amplitude control.

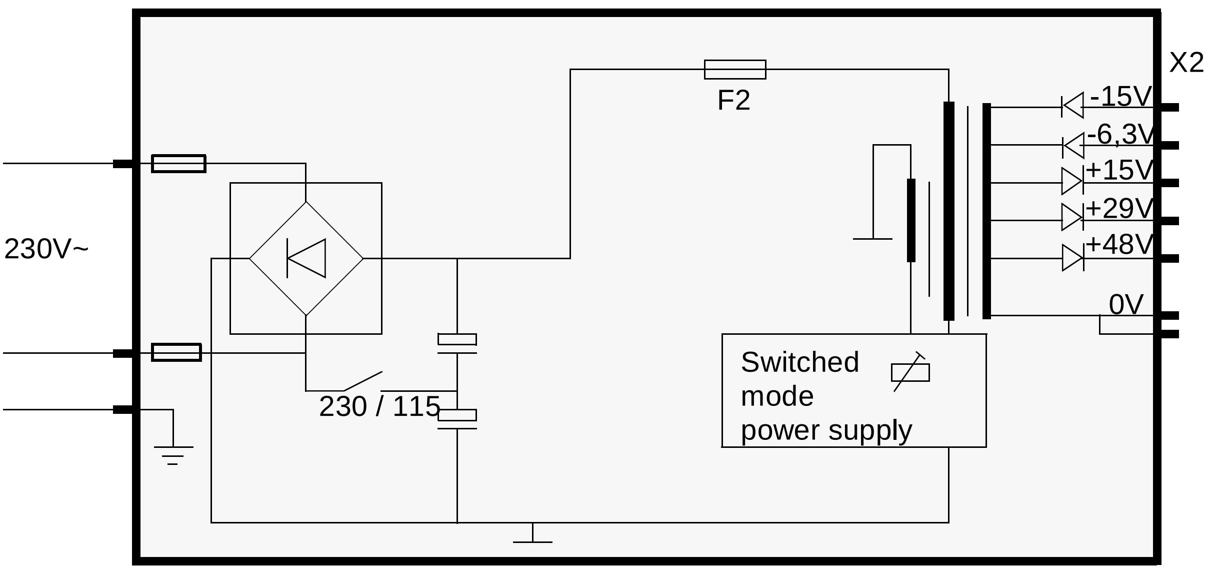
High voltage monitoring

For monitoring the high voltage actual value is divided down by a voltage divider and compared in the monitoring with a minimum value. If it is less than this value, the H actuation is blocked. The unit must be switched off and back on to restart.

Electronic mask

Masks can be set individually on the right or left for blanking in the monitor.

Power supply board



The supply voltages for the monitor are generated on the power supply board with a switched mode power supply controlled on the primary side. The switching frequency of the power supply unit is 25 KHz. Supply voltages of ±15 V; +29 V; +48 V and 6.3 V (for picture tube filament) are generated.